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Port Needs Study (Vessel Traffic Services Benefits)

Volume II: Appendices, Part 2

Research and Special Programs
Administration
John A. Volpe National
Transportation Systems Center
Cambridge MA 02142-1093

August 1991

U.S. Department
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16. Abstract

This stu documents the benefits and costs of potential U.S. Coast Guard Vessel Traffic rvices (VTS) in selected U.S. deep water ports on the Atlantic, Gulf and Pacific Coasts. The U.S. Department of Transportation's Research and Special Programs Administration's Volpe National Transportation Systems Center (VNTSC) conducted the study for the U.S. Coast Guard, Office of Navigation Safety and Waterway Service, Special Projects Staff. The entire study is documented in three separately bound volumes plus a separate Study Overview. Volume I is the main document covering all aspects of the input data, analysis methods, and results. The focus of Volume I is presentation of information across all 23 study zones concurrently. Volume II focuses on organization and presentation of information for each individual study zone. It contains the appendix tables of input data, output statistics and the documentation of the candidate Vessel Traffic Services (VTS) Design by NavCom Systems. Volume III is a compendium of technical papers on data sources, analytical methods, and models supplementing material in Volume I.

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METRIC / ENGLISH CONVERSION FACTORS

ENGLISH TO METRIC

LENGTH (APPROXIMATE)

1 inch (in) = 2.5 centimeters (cm)
1 foot (ft) = 30 centimeters (cm)
1 yard (yd) = 0.9 meter (m)
1 mile (mi) = 1.6 kilometers (km)

AREA (APPROXIMATE)

1 square inch (sq in, in^2) = 6.5 square centimeters (cm^2)
1 square foot (sq ft, ft^2) = 0.09 square meter (m^2)
1 square yard (sq yd, yd^2) = 0.8 square meter (m^2)
1 square mile (sq mi, mi^2) = 2.6 square kilometers (km^2)
1 acre = 0.4 hectares (he) = 4,000 square meters (m^2)

MASS - WEIGHT (APPROXIMATE)

1 ounce (oz) = 28 grams (gr)
1 pound (lb) = .45 kilogram (kg)
1 short ton = 2,000 pounds (lb) = 0.9 tonne (t)

VOLUME (APPROXIMATE)

1 teaspoon (tsp) = 5 milliliters (ml)
1 tablespoon (tbsp) = 15 milliliters (ml)
1 fluid ounce (fl oz) = 30 milliliters (ml)
1 cup (c) = 0.24 liter (l)
1 pint (pt) = 0.47 liter (l)
1 quart (qt) = 0.96 liter (l)
1 gallon (gal) = 3.8 liters (l)
1 cubic foot (cu ft, ft^3) = 0.03 cubic meter (m^3)
1 cubic yard (cu yd, yd^3) = 0.76 cubic meter (m^3)

TEMPERATURE (EXACT)

[(x - 32)(5/9)] °F = y °C

METRIC TO ENGLISH

LENGTH (APPROXIMATE)

1 millimeter (mm) = 0.04 inch (in)
1 centimeter (cm) = 0.4 inch (in)
1 meter (m) = 3.3 feet (ft)
1 meter (m) = 1.1 yards (yd)
1 kilometer (km) = 0.6 mile (mi)

AREA (APPROXIMATE)

1 square centimeter (cm^2) = 0.16 square inch (sq in, in^2)
1 square meter (m^2) = 1.2 square yards (sq yd, yd^2)
1 square kilometer (km^2) = 0.4 square mile (sq mi, mi^2)
1 hectare (he) = 10,000 square meters (m^2) = 2.5 acres

MASS - WEIGHT (APPROXIMATE)

1 gram (gr) = 0.036 ounce (oz)
1 kilogram (kg) = 2.2 pounds (lb)
1 tonne (t) = 1,000 kilograms (kg) = 1.1 short tons

VOLUME (APPROXIMATE)

1 milliliter (ml) = 0.03 fluid ounce (fl oz)
1 liter (l) = 2.1 pints (pt)
1 liter (l) = 1.06 quarts (qt)
1 liter (l) = 0.26 gallon (gal)
1 cubic meter (m^3) = 36 cubic feet (cu ft, ft^3)
1 cubic meter (m^3) = 1.3 cubic yards (cu yd, yd^3)

TEMPERATURE (EXACT)

[(9/5) y + 32] °C = x °F

QUICK INCH-CENTIMETER LENGTH CONVERSION

INCHES	0	1	2	3	4	5	6	7	8	9	10

CENTIMETERS 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 | 25.40

QUICK FAHRENHEIT-CELCIUS TEMPERATURE CONVERSION

°F	-40°	-22°	-4°	14°	32°	50°	68°	86°	104°	122°	140°	158°	176°	194°	212°
°C	-40°	-30°	-20°	-10°	0°	10°	20°	30°	40°	50°	60°	70°	80°	90°	100°

For more exact and or other conversion factors, see NBS Miscellaneous Publication 286, Units of Weights and Measures. Price $2.50. SD Catalog No. C13 10 286.

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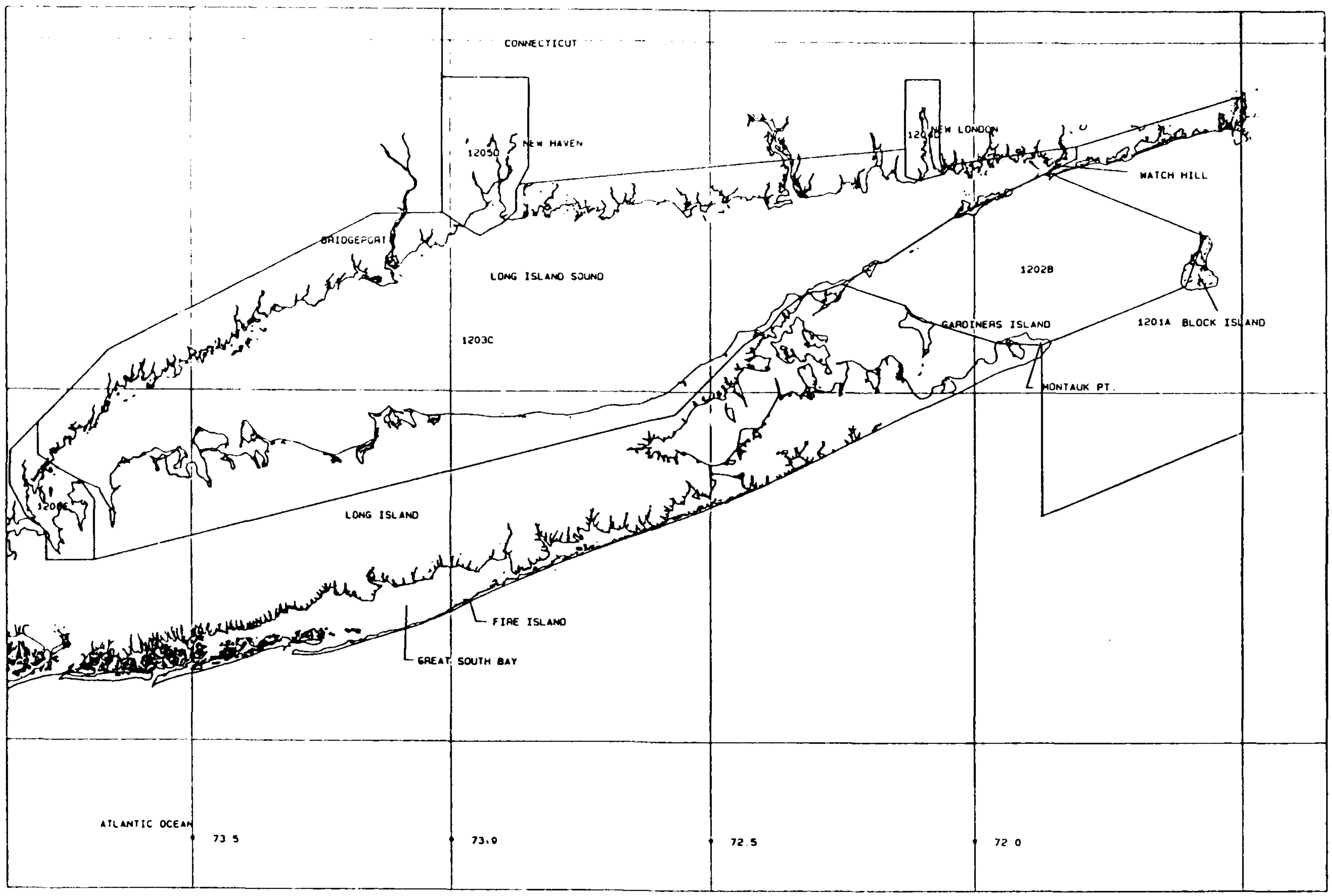
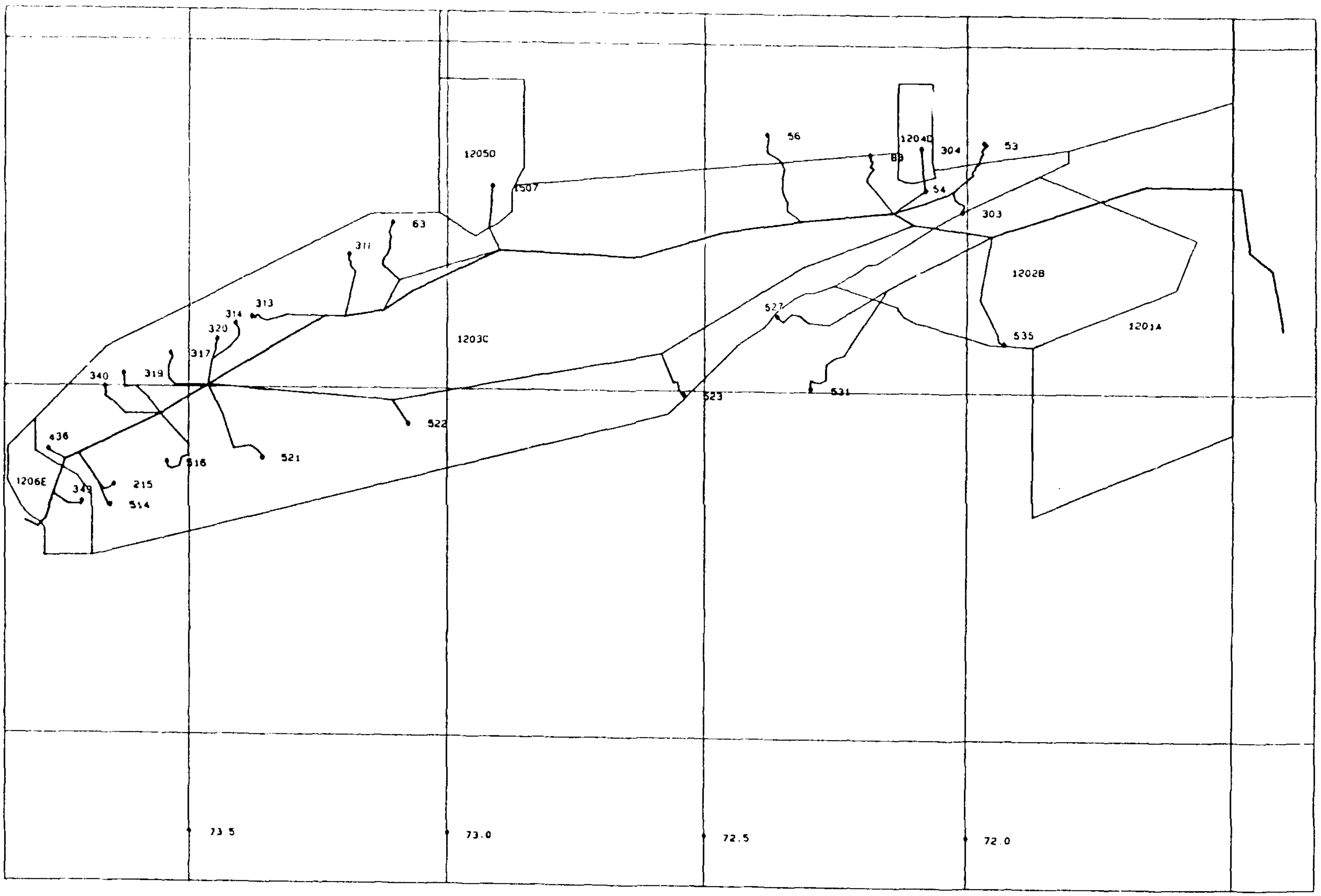
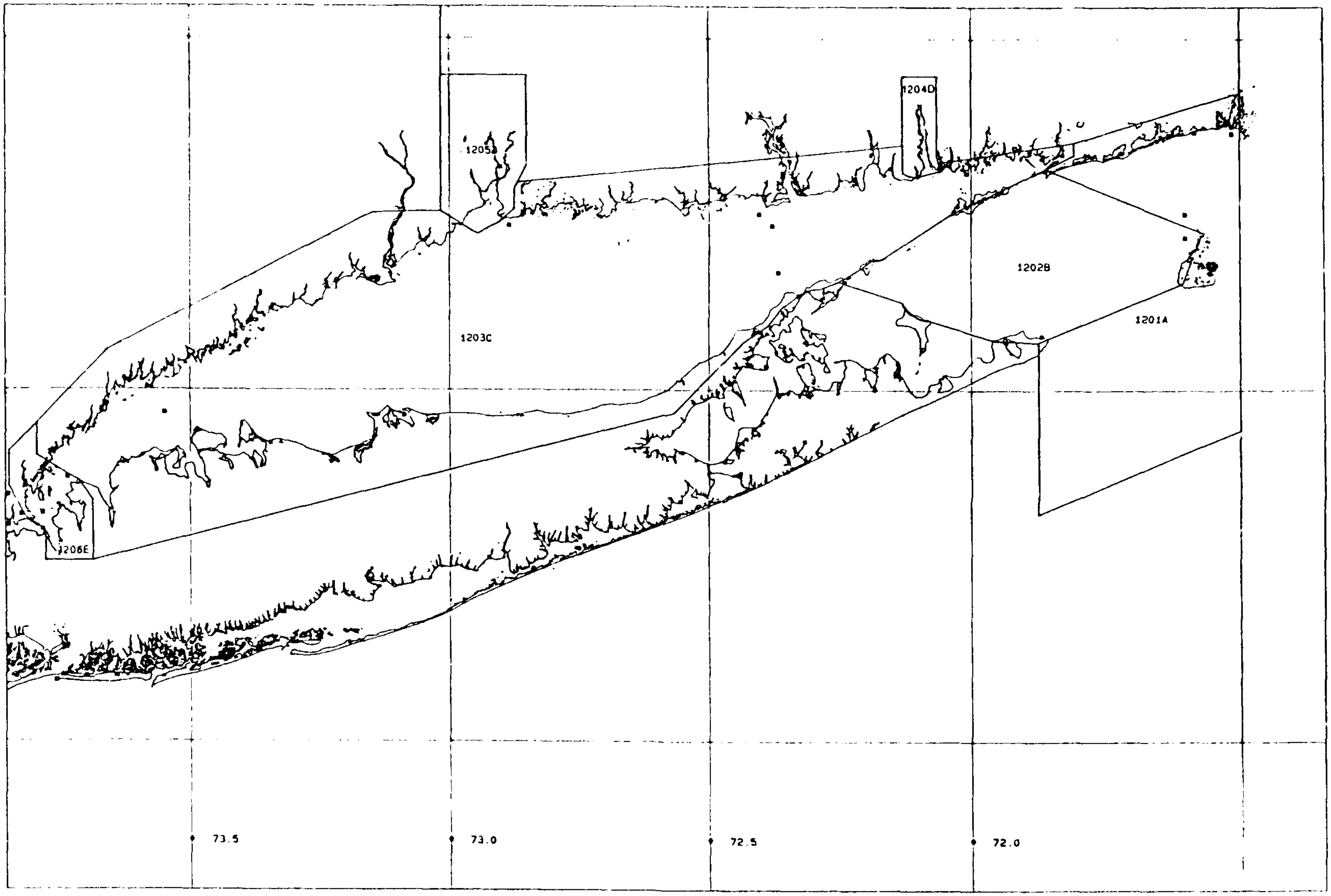


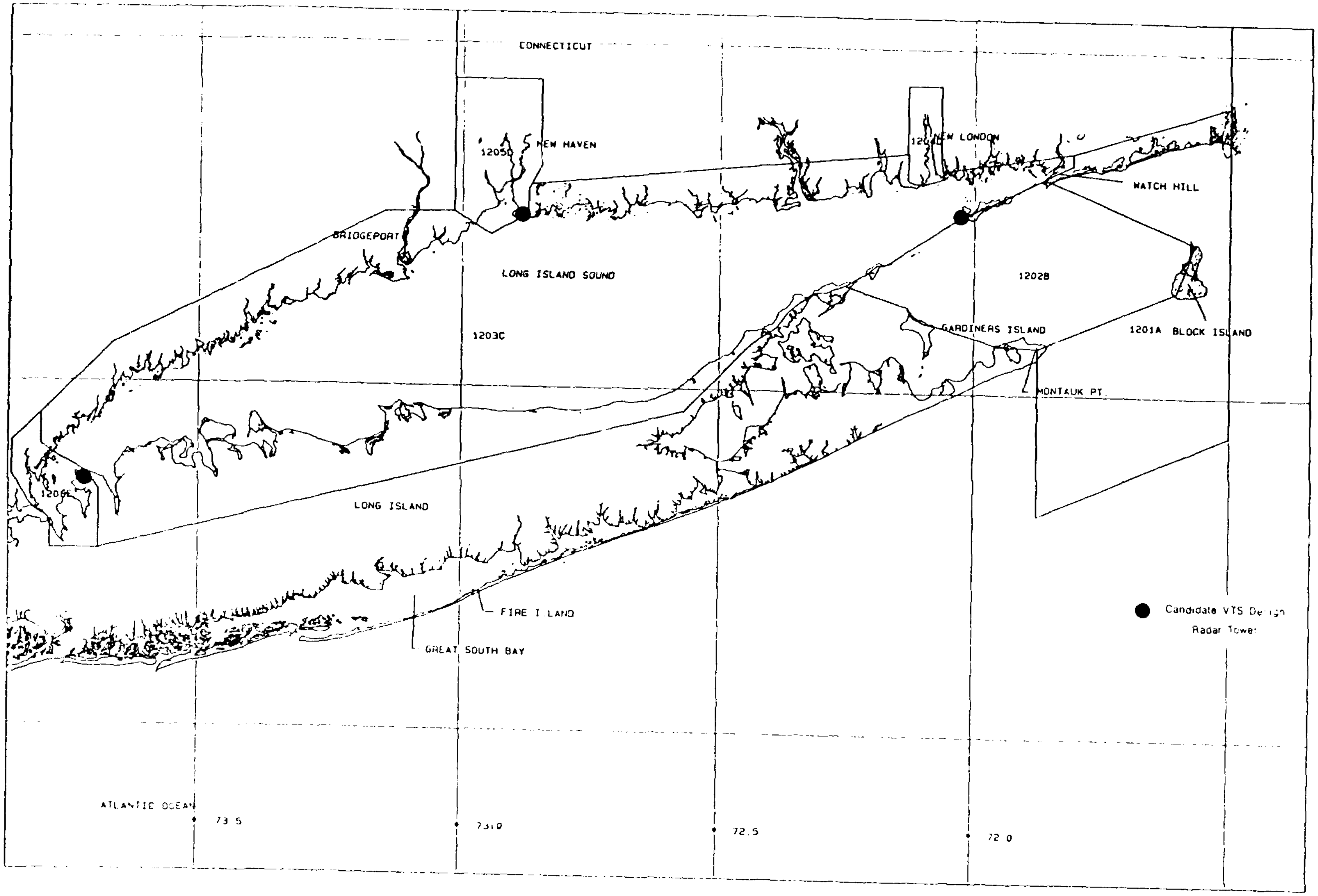
ZONE 12 - LONG ISLAND SOUND, NY - ZONE AND SUBZONE BOUNDARIES



ZONE 12 - LONG ISLAND SOUND, NY - DOMINANT VESSEL ROUTES AND COE WATERWAY CODES



ZONE 12 - LONG ISLAND SOUND, NY - BASE PERIOD (10 YEAR) VESSEL CASUALTIES



ZONE 12 - LONG ISLAND SOUND, NY - CANDIDATE VTS DESIGN RADAR LOCATIONS

CANDIDATE VTS DESIGN REPORT

FOR

LONG ISLAND SOUND, NY

(ZONE 12)

Prepared for:
U.S. Department of Transportation
Research and Special Programs Administration
John A. Volpe National Transportation Systems Center
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July 1991

OVERVIEW

The Candidate VTS Design described in this appendix is one of 23 developed for all the study zones included in the study. This appendix documents the task performed, under Contract DTRS-57-88-C-00088 Technical Task Directive 13, as an integral part of the total Port Needs Study. The ultimate product of this task effort is an informed preliminary technical assessment of the approximate cost to the Federal Government to implement and operate a state-of-the-art VTS system. This appendix does not contain a comprehensive definition of the VTS operating requirements nor does it propose a final VTS specification suitable for implementation.

In order to consistently estimate the life cycle costs of a VTS system in each of the study zones, a "Candidate VTS Design" has been defined for each study zone using a uniform set of design criteria. Each study zone Candidate VTS Design is a composite of generic modules selected from a master list of 18 state-of-the-art surveillance modules, communications and display technology. Among the surveillance modules in the master list are several levels of technical performance from which the selection is made for application to each study sub-zone to address the local navigational surveillance needs and conditions. The Candidate VTS Design in each study zone represents a consistent application of the surveillance modules at the sub-zone level. The sub-zone surveillance technology is subsequently integrated into a total system for the study zone via state-of-the-art communications and display consoles at the Vessel Traffic Center (VTC) in each zone.

The application of the surveillance modules in each sub-zone responds to the technical requirements of that sub-zone as perceived by the study team. The Candidate VTS Design represents a preliminary engineering judgement on the appropriate level of technology in each sub-zone. The Candidate VTS Design may be considered as an informed judgement made by the contractor study team for the sole purpose of developing cost estimates that are consistent across the 23 study zones and suitable for benefit/cost comparisons among the study zones and initial budget planning and implementation priorities. The approach used to calculate VTS system costs for all 23 study zones is found in Volume III, Technical Supplement.

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LONG ISLAND SOUND VTS DESIGN

1.0 SCOPE

This report includes a survey and a VTS design for the Long Island Sound. This survey is based on a review of all pertinent literature including navigational charts. The methodology used to produce the VTS design entails coupling the problems identified in the survey with solutions offered by state-of-the-art technology as identified in the VTS Technology Survey, November 1990. When possible, technological advances which permit manpower reductions are applied. Not all VTS problems are amenable to strictly technological solutions; some require changes in procedures and/or enforcement. These situations are identified where they occur.

2.0 LONG ISLAND SOUND SURVEY

2.1 INTRODUCTION

This survey report is based exclusively upon review of available literature and examination of the charts for the area and its approaches. The information thus gained has been evaluated and interpreted based upon the Survey Team's experience as professional mariners and in vessel traffic management systems.

The Survey Area includes Long Island Sound from Execution Rocks to the Race. Ports opening to Long Island Sound are <u>not</u> included.

Long Island Sound supports several and varied marine traffic flows. There is the relatively infrequent deep-draft ships using the Sound for transit between New York and New England ports. A small volume of smaller tankers, bulkers and general cargo ships call at ports opening upon the Sound and there is barge traffic. The barge traffic flow is through the Sound between New York and New England and intra-Sound. The area is heavily used, in season, by recreational boaters, with the heaviest concentrations in the western portions of the surveyed area. A small volume of U. S. Navy ships, primarily submarines, transit the area between New London and the Race.

2.2 OVERVIEW OF THE PORT

Long Island Sound is a deep navigable waterway lying between the shores of Connecticut and New York and the northern coast of Long Island. The waters are well marked by aids to navigation, both fixed aids and buoys, and the shoreline provides excellent radar returns. Winter icing may cause removal of some buoys to prevent damage and buoys may be displaced from station by ice movement. Icing, however, generally affects only the buoys in the still waters of harbors.

Climate within the Survey Area is typically coastal southern New England. The north and south shores are equally subject to fog, except that on spring and summer mornings when there is little wind, fog may occur along the Connecticut shore while it is clear offshore. The eastern end of the Sound is more prone to prolonged periods of fog than the west. On average, the area experiences about 30 days per year during which the visibility is below 0.25 mile.

The diurnal tidal range is 2.5 feet in the eastern end of the Sound and 7.3 feet in the western end. Tidal currents can be particularly strong at either end of the Sound. For example, currents through the Race frequently exceed six knots at maximum ebb. The information contained by the tidal current charts is accurate, however, and tidal effects upon shipping are generally very predictable.

The Race is the main entrance to Long Island Sound from the east. Although well marked, the Race is subject to strong currents and tide rips. The tide rips are particularly strong during heavy weather when the wind opposes the tide. Underpowered vessels should use good judgement in selecting times of transits.

Execution Rocks, which marks the western entrance to the Study Area, offers a narrower passage than the Race but lacks the same degree of tidal turbulence.

Pilotage is compulsory for all foreign-flag ships and U. S.-flag ships under register in the foreign trade. Pilots board ships westbound for Long Island Sound transits and ports in the vicinity of Brenton Reef Light (Off Narragansett Bay), about eight miles eastward of Montauk Point or in the vicinity of Point Judith Lighted Whistle Buoy 2. Ships entering Long Island Sound from the west take their pilots near Execution Rocks.

Pilots for Long Island Sound are available from the Constitution State Pilots Association (Hartford, CT), Northeast Pilots, Inc. (Newport, RI), Interport Pilots Agency (Atlantic Highlands, NJ), Sandy Hook Pilots (Staten Island, NY), Long Island State Pilots Association (Seaford, DE), and Associated Coast Pilots (Parsippany, NJ).

Pilot boats monitor VHF-FM channels 11, 16, and 18A for at least one hour before expected ship arrivals and use CH11 and CH18A as working frequencies.

Long Island Sound is well-marked by aids to navigation, both buoys and fixed aids, and radar navigation is facilitated by the excellent returns from the highly relieved shorelines.

2.3 EXISTING TRAFFIC MANAGEMENT

2.3.1 Anchorages

There are a significant number of general and special anchorages within the waters of Long Island Sound, primarily adjacent to the many small harbors. The Coast Pilot (Reference 1) should be consulted for details.

2.4 VESSEL TRAFFIC

Traffic statistics available for Long Island Sound are fragmented at best, and heavy dependence was placed upon the Transportation Systems Center's Trip Report. Review of the Trip Report suggest pilot distortion of traffic management problems, particularly with respect to the degree of congestion.

The Trip Report data indicates 4500 tank ship/tank barge movements per year through the Sound. Five hundred tank ships call at Sound ports, primarily New Haven, Bridgeport, Port Jefferson and New London. Other commercial traffic is light. USN traffic is essentially between New London and the sea and probably averages 5 moves per week.

Principal traffic through the Sound in recent years has been coastal tankers which are small enough to enter the smaller harbors and rivers (the Connecticut and Housatonic), and barges. Barge traffic tends to be two types, intra-Sound and trans-Sound, with the trans-Sound traffic bound between New York and ports east and north of Long Island Sound.

Recreational traffic is heavy but seasonal, from late May to September. Scheduled races and regattas give rise to heavy concentrations for short periods, and tend to be more of a problem in the Western Sound than to the east.

There tends to be little commercial cross-Sound traffic except for the ferry between New London and Orient Point, and the summer ferry between New Haven and Port Jefferson. Traffic flow is otherwise east and west. Deep-draft traffic tends to keep to the center axis of the Sound, as do the trans-Sound shoal-draft vessels. The intra-Sound traffic tends to skirt the north shore, clear of the deep-draft lanes. Deep-draft ships serving ports on Long Island Sound are generally limited to New Haven, Bridgeport, Port Jefferson and New London.

2.5 ENVIRONMENTAL SENSITIVITY

Non-marine pollution has largely destroyed the once-important fisheries but some menhaden, lobsters, scallops and shellfish are still taken in the eastern portion. Although the shoreline is environmentally sensitive, and the southern shore forms the habitat for aquatic birds, the greatest impact of a marine pollution

incident will be upon the quality of life for the area's many residents.

"Worse case" pollution incidents probably involve major tank rupture as the result of a navigational error or collision involving a tank ship or barge.

2.6 PORT SUB-ZONES

The Study Area was examined to determine appropriate sub-zones, using the methodology based upon the "confined-complex", "open-complex", "confined-simple" and "open-simple" system employed by the Canadian VTS Study in 1984 (Reference 2). Briefly stated, "open" and "confined" address the influence of geography upon a ship's ability to maneuver; and "simple" vs "complex" is descriptive of the nature of the interactions between ships within those geographic areas. This basic matrix was overlaid by a subjective assessment of appropriate traffic management/risk amelioration measures in order to derive sub-zones within which VTS needs are homogeneous, or nearly so.

2.6.1 Sub-Zone I -- Eastern Approaches (NOAA Chart 13205)

The sub-zone consists of that portion of Block Island Sound and Gardiners Bay east of 72^0-00'W, and south of a line drawn at 41^0-10'N between Plum Island Gut and 72^0-00'W.

The sub-zone functions essentially as a data catchment area for shipping entering the Long Island Sound VTS Zone from the east. The principal function of the VTS within the sub-zone is thus to establish communications with inbound traffic and obtain information about characteristics, intentions and movements.

The sub-zone is "open-simple."

2.6.2 Sub-Zone II -- Western Approaches (NOAA Chart 12363)

The sub-zone consists of that portion of Long Island Sound and the East River lying to the west of 73^0-44.2'W.

The sub-zone functions essentially as a data catchment area for shipping entering the Long Island Sound VTS Zone from the west. The principal function of the VTS within the sub-zone is thus to receive hand-offs from VTS New York, establish communications with inbound traffic and obtain information about characteristics, intentions and movements. Information about traffic entering the New York VTS Zone from Long Island Sound is an important input to that system.

The sub-zone is "confined-complex."

2.6.3 Sub-Zone III -- Long Island Sound (NOAA Charts 12363 & 12354)

The sub-zone consists of all of Long Island Sound between the boundaries of Sub-Zone I (that portion of Block Island Sound and Gardiners Bay east of 72^0-00'W, and south of a line drawn at 41^{0}-10'N between Plum Island Gut and 72^0-00'W) and Sub-Zone II (that portion of Long Island Sound and the East River lying to the west of 73^0-44.2'W). Harbors and rivers tributary to Long Island Sound are excluded from the sub-zone by lines their entrances.

The sub-zone consists of a body of water akin to the Santa Barbara Channel, but with an absence of offshore oil activity.
Movement management advice will contribute to safety, especially in the vicinity of the Race, Execution Rocks and the area of Stratford Shoal Middle Ground. Vessels entering the VTS area from rivers and ports along the Sound should be required to report to the VTC by radio 30 minutes prior to entry.

The sub-zone is "confined-simple."

2.7 PROBLEM AREA IDENTIFIERS

2.7.1 PAI III-1. The Race

The Race, while relatively open, is a poor point for an adverse meeting or crossing to occur because of the strong currents. At maximum ebb, for example, velocities cab exceed six knots. Movement management advice is appropriate.

2.7.2 PAI III-2. Execution Rocks

The broad expanse of the Sound necks down at Execution Rocks and from there to New York's East River is a confining channel. The vicinity of Execution Rocks can be crowded with recreational boats during summer holidays and weekends. Advice about scheduled regattas and traffic movement is appropriate.

3.0 LONG ISLAND SOUND VTS DESIGN

3.1 INTRODUCTION

A detailed survey of the Long Island Sound is the basis for this design. An approach to costing VTS systems is outlined in Vol. III, Technical Supplement and a method of categorizing surveillance sensors into "modules" has also been developed. These modules are defined in terms of cost and performance and are to be applied to all VTS designs in this study. The applicability of Automatic Dependent Surveillance (ADS) technology is also discussed in this report. The three sub-zones defined in the harbor survey remain the same.

Traffic management requirements for each sub-zone are developed from PAI analysis. Table 3-1 lists in tabular form a summation of the problems identified and the management required by sub-zone.

The hardware and software selected for this design provide the level of surveillance justified by the problems identified in each sub-zone. A secondary consideration is to locate all VTS assets so that they are sufficient for the sub-zone in question and can contribute to adjoining sub-zones to achieve maximum usage. All specific equipments are then selected based on perceived surveillance requirements and overall VTS system architecture.

3.1.1 VTS Design Approach

The choice of surveillance sensors is dependent on the VTS mission. For the purposes of this design, the VTS mission is defined as that which insures the safety of navigation and the protection of the environment. In order to accomplish this mission, mandatory participation of all vessels over 20 meters is essential. The Vessel Traffic Center (VTC) must provide navigation safety advice to all vessels. The VTS in the United States will have no facilitation of commerce role nor will it offer piloting assistance of any kind.

The primary criteria for selection of adequate surveillance sensors are:

- o Percentage of vessels of the desired minimum size detected in designated surveillance areas
- o Percentage of lost tracks
- o Accuracy of the position and track obtained
- o Reliability of the surveillance system
- o Timeliness of the data obtained
- o Ability to interpret and use the data obtained

Secondary criteria are:

- o Cost of the VTS system -- reduction of manpower by the use of technology
- o Expandability -- increased VTS responsibility, area, and/or support of other missions

TABLE 3-1. ADDITIONAL COST REQUIRED FOR ADDING SURVEILLANCE EQUIPMENT

PAI	LOCATION	PROBLEM	MANAGEMENT
I	Eastern Approaches	Data catchment area for inbound shipping.	Have knowledge of vessel movements, locations through reporting. Enter inbound shipping information into database.
II	Western Approaches	Same As Above.	Same As Above.
III	Long Island Sound	Potential congestion and difficult meetings.	Have knowledge of vessel movements, locations through reporting. Provide movement management advice.

Active surveillance sensors including radar, communications, and closed circuit television (CCTV) installations are used when detection and tracking of vessels is paramount to providing safety advice. These devices are considered fail safe in that it is known with certainty when they have failed. The performance characteristics of these sensors are known from operational VTS worldwide experience. In this design they are selected to assure that the necessary operational criteria identified for each sub-zone is realized.

Many dependent surveillance techniques are possible. These range from voice radio reporting of required VTS data to automatic position and identification recording devices that can be interrogated from shore known as Automatic Dependent Surveillance (ADS) devices. The position and/or movement reporting form of dependent surveillance is used extensively in existing VTS systems. The major regions of current use are those which do not require active surveillance. To apply ADS technology to a specific sub-zone within a VTS zone the following additional criteria must be considered:

- o The number and class of vessels interacting in the sub-zone and which of these interactions are important to the VTS mission. Obviously all vessel classes of interest must be appropriately equipped. This requires that all vessels of the classes selected which will ever pass through this sub-zone must be equipped with an ADS device. This requirement to detect so many different vessels argues against the use of ADS. In areas where only one class of vessel is of interest, ADS is more easily implemented.

- o The interactions or transits to be monitored must not demand that the surveillance be fail safe, i.e. positively detecting failures. This type of surveillance is related to position reporting in that it may not always function or be used properly and the VTS has limited control over its operation.

- o It must be determined that if active surveillance is not justified, the additional information obtained from ADS over position reporting is necessary.

- o If the class or group of vessels to be monitored is a "controllable" group, ADS can be easily implemented and satisfactory operation more readily achieved. Controllable means a clearly defined subset of vessels, e.g. a specific barge company; vessels carrying a specific cargo, etc.

o The number of different vessels in each class of interest that passes through the sub-zone in question must be determined. This number must be known to accurately estimate the cost of selecting this option for this sub-zone.

o A specific ADS solution for one sub-zone in one harbor may affect all the VTS designs for all the other sub-zones in all the other harbors.

3.1.2 Assumptions

The design of this VTS system starts with a set of assumptions based on the detailed survey and other data. These assumptions are as follows:

o As recommended by the IMO, all vessels of 20 meters or more in length are required to participate in the VTS. Participation is defined (at a minimum) as monitoring the VTS frequency and reporting as required.

o The VTS system is implemented with the cooperation and assistance of the port authorities, pilots associations, and marine exchange, if any. The existing facilities, services, and procedures established and operated by these organizations are major elements of an integrated VTS system as defined in the IMO VTS Guidelines.

o The life-cycle of all system hardware is ten years.

3.2 DESIGN DECISIONS (FIGURE 3-1)

3.2.1 General

Examination of the traffic levels, geographical features and identified problem areas in the area leads to the following selection and location of sensor hardware.

3.2.2 Hardware Location and Selection

3.2.2.1 Sub-Zone III

Race Point Site	1 Module 3 radar 1 Module 10 VHF 1 Module 11 VHF 1 Module 13 MET 1 Module 15 HYD
New Haven Site	1 Module 10 VHF

Surveillance Modules -Sub Zones	RADAR						ADS			VHF		MET.		HYD.		DF	CCTV		COMMENTS
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
I																			Comms coverage from Sub-Zone III
II																			Comms coverage from Sub-Zone III
III			2							5	2		2		1				

FIGURE 3-1. LONG ISLAND SOUND, NY SURVEILLANCE SURVEY

South Norwalk Site	1 Module 10 VHF
Sands Point Site	1 Module 3 radar 1 Module 10 VHF 1 Module 11 VHF 1 Module 13 MET
Crane Neck Site	1 Module 10 VHF

3.2.3 Vessel Traffic Center

The design of the hardware and software should be modern and capable of operating with reduced staff levels and no loss of effectiveness. One watchstander with an integrated data workstation and decision aiding software can effectively manage the activity in this port. This Vessel Traffic Center concept demands that the watchstander be separated from any other harbor/port information requests. The Center must be structured so that such requests are controlled by a bulletin board type interface. One officer-in-charge and one clerk are also required for the proper administration of the facility.

The Vessel Traffic Center is located at New London in a location with good visual surveillance of the Thames River entrance. The center is to employ the following equipment:

3.2.3.1 VTS Console

This console provides total data integration from all sensors in all sectors. These data are graphically shown on raster scan, high light level, color displays. A data display is also provided. Console design architecture is general purpose computer based, open architecture, bus organized, allowing operation of the system as a local area network (LAN). Data interchange with other facilities by modem is provided as well as interface with the U.S. Coast Guard standard terminal. The design allows board level modification and expansion. Features of the software and hardware provided are:

- o Software written in a high level language.
- o Software providing the total integration of data from all VTS sensors.
- o Layering of data in at least four layers to be operator selectable.
- o The ability to sector data including sector to sector handoff of targets.

- The ability to accept external digital data derived from transmissions of shipboard transponders or other sources and integrate the information with all other sensor data.

- Automatic and/or manual acquisition of radar targets including automatic tracking and target ID assignments. Guard zones with automatic acquisition of all targets entering the zone.

- Several warning levels of vessel interaction designed to direct attention to developing situations rather than a simple CPA alarm strategy.

- Complete vessel monitoring and alarm capability including anchor watch, CPA, TCPA, track history, adjustable target velocity vectors, restricted area penetration and maneuvering monitor is provided. Additional warning and/or alarm features allowed by programming changes in high level language.

- Complete modern color graphics capability with offset and zoom

- Complete harbor navigation aid monitoring capability including buoy position, light status, etc.

- Remote control of all radars and radar interfaces as well as radar data processing including site-to-site integration, clutter suppression, scan conversion and target extraction.

- Complete track projection capability which can predict and/or analyze future interactions based on current position, destination and velocity.

- The capability of constructing a complete vessel data base and interfacing it to the real-time data display from the VTS sensors.

3.2.3.2 Communications Console

This console is capable of remotely operating the proposed transmitting/receiving sites and allowing transmission and monitoring on all required frequencies. The console provides two operating positions each to be capable of complete communications control. It is capable of modular expansion if other remote communications sites are added.

3.2.3.3 Supervisor Control and Data Acquisition (SCADA) Equipment

A SCADA capability is provided to the major module level at remote sites so that the watchstander can determine the status of the entire VTS system. A graphic readout is provided in block diagram form indicating operational status of all elements in the system. Security monitoring of remote sites is also included.

3.2.3.4 Recording Equipment

Time synchronized video and audio recording equipment is to be provided. This equipment is capable of recording and playing back the data presented to the VTS watchstander and his reaction to the situation. An extra set of recording equipment is to be installed for redundancy purposes.

3.3 COST ESTIMATES

3.3.1 General

Vol. III, Technical Supplement discusses a generalized approach to estimating VTS system costs. This approach is based on interviews with system designers and purchasers of recently constructed systems. The cost of this VTS system has been estimated using this approach and is detailed below. The assumptions made in estimating these costs are listed in Paragraph 3.1.2.

3.3.2 Hardware (x $1000)

Vessel Traffic Center	non-recurring	recurring(10-yr)
VTS Console (1 workstation & all software)	500	
Communications console	100	
Recording Equipment	50	
SCADA Equipment (2 radar sites)	200	
Sub-total:	850	400

Sub-Zone I--Eastern Approaches (NOAA Chart 13205)

Comms/radar coverage from Sub-Zone III.

Sub-Zone II--Western Approaches (NOAA Chart 12363)

Comms/radar coverage from Sub-Zone III.

Sub-Zone III--Long Island Sound (NOAA Charts 12363 & 12354)

2 Module 3 radar	800	800
5 Module 10 VHF	95	65
2 Module 11 VHF	96	40
2 Module 13 MET	80	10
1 Module 15 HYD	50	5
Sub-total:	1121	920
HARDWARE TOTALS:	1971	1320

3.3.3 Project Totals (x $1000)

Non-recurring

Hardware	$1971
Management, Engineering, etc. (50%) Assumptions: Turnkey system, Procurement by integ.contractor, good manufacturer support, some software provided, System Manual required	986
Installation site integration (20%) Assumptions: Complete installation by contractor, remote access no serious problem, many widespread sites	394
Spares & Training (10%)	197
Civil Engineering 2 remote radar sites, a VTC in New London, remote comms and WX sensors installations, land acquisition	1000
PROJECT ESTIMATE:	4548
Data Base Management System	300
TOTAL: (non-recurring)	$ 4848

Recurring (10 year)

Hardware	1320
1 Watchstander x 5 = 5 man/years @ 50K x 10	2500
1 Officer-in-Charge	500
1 Clerk	500
TOTAL: (recurring) (10-year life)	$ 4820
TOTAL 10-YEAR PROJECT COST:	$ 9668

REFERENCES

1. United States Coast Pilot, Atlantic Coast: Cape Cod to Sandy Hook, 24th Edition, 1989, NOAA, Washington, D.C. pp. 28-32.

2. Final Report, National Vessel Traffic Services Study (TP5965E), Canadian Coast Guard, Ottawa 1984, pp.89-91.

GLOSSARY

ADS: Automatic Dependent Surveillance

ARPA: Automatic Radar Plotting Aid.

"CONFINED-COMPLEX": a combination of terms relating to the geography and the nature of the interactions between ships. See Final Report National Vessel Traffic Services Study (TP-5965E), Canadian Coast Guard, Ottawa, October 1984, pp.89-91.

"CONFINED-SIMPLE": a combination terms relating to the geography and the nature of the interactions between ships. See Final Report National Vessel Traffic Services Study (TP-5965E), Canadian Coast Guard, Ottawa, October 1984, pp.89-91.

COTP: Captain of the Port

CCTV: closed circuit television

COLREGS LINE: a demarcation line delineating those waters upon which international regulations for the prevention of collisions at sea apply.

CPA: closest point of approach

DBMS: data base management system

DF: direction finder

FAA: Federal Aviation Administration

GIS: Geographic Information System

ICW: Intracoastal Waterway

IMO: International Maritime Organization

KW: Kilowatt

LAN: local area network

LLOYD'S LIST: a listing of all merchant vessels of the world including their physical characteristics. Published by Lloyd's of London.

LNG: liquified natural gas

NOAA: National Oceanic and Atmospheric Administration

"OPEN-COMPLEX": a combination of terms relating to the geography and the nature of the interactions between ships. See Final Report National Vessel Traffic Services Study (TP-5965E), Canadian Coast Guard, Ottawa, October 1984, pp. 89-91.

"OPEN-SIMPLE": a combination of terms relating to the geography and the nature of the interactions between ships. See Final Report National Vessel Traffic Services Study (TP-5965E), Canadian Coast Guard, Ottawa, October 1984, pp. 89-91.

PAI: Problem Area Identifier

PRECAUTIONARY AREA: an area normally an intersection, entrance to, or exit from a traffic separation scheme where vessel interactions are unpredictable

SCADA: Supervisor Control and Data Acquisition

TCPA: time of closest point of approach

TRAFFIC SEPARATION SCHEME: routes incorporating traffic separation to increase the safety of navigation, particularly in converging areas of high traffic density.

VHF: very high frequency

VTC: vessel traffic center

VTS: vessel traffic services

APPENDIX

ADDITIONAL COST REQUIRED FOR ADDING

SURVEILLANCE EQUIPMENT

LONG ISLAND SOUND, NEW YORK (Including Additional Radar)

1.0 HARDWARE COSTS (x $1000)

Vessel Traffic Center	non-recurring	recurring (10-yr)
VTS Console (1 workstation & all software)	500	
Communications console	100	
Recording Equipment	50	
SCADA Equipment (2 radar sites)	200	
Sub-total:	850	400

Sub-Zone I--Eastern Approaches (NOAA Chart 13205)

Comms/radar coverage from Sub-Zone III.

Sub-Zone II--Western Approaches (NOAA Chart 12363)

Comms/radar coverage from Sub-Zone III.

Suib-Zone III--Long Island Sound (NOAA Charts 12363 & 12354)

1 Module 1 radar	310	310
2 Module 1 radar	800	800
5 Module 1 10 VHF	95	650
2 Module 1 11 VFH	96	400
2 Module 1 13 MET	80	10
1 Module 1 15 HYD	50	5
Sub-tota:	1431	1230
HARDWARE TOTALS:	2281	1630

2.0 PROJECT TOTALS (x $1000)

2.1 NON-RECURRING

	With Add'l. Radar
Hardware	2281
Management, Engineering, etc. (50%) Assumptions: Turnkey system, Procurement by integ. contractor, good manufacturer support, some software provided, System Manual required	1141
Installation site integraiton (20) Assumptions: Complete installation by contractor, remote access no serious problem, many widespread sites	456
Spares & Training (10%)	228
Civil Engineering 2 remote radar sites, a VTC in New London, remote comms and WX sensors installations, land acquisition	1300
PROJECT ESTIMATE:	5406
Data Base Managemet System	300
TOTAL: (non-recurring)	5706

2.2 RECURRING (10 YEAR)

Hardware	1630
1 Watchstander x 5 = 5 man/years @ 50K x 10	2500
1 Officer-in-Charge	500
1 Clerk	500
TOTAL: (recurring) 10-year life)	5130
TOTAL 10-YEAR PROJECT COST:	$10836

COMMENTS:

1. The port survey indicates that no radar coverage is justified by the traffic levels and interactions.

2. The two Problem Areas identified (Execution Rocks and The Race) were provided radar coverage because of the preliminary nature of the survey.

Surveillance Modules -Sub Zones	RADAR						ADS			VHF		MET.		HYD.		DF	CCTV		COMMENTS
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
I																			Comms coverage from Sub-Zone III
II																			Comms coverage from Sub-Zone III
III	1		2							5	2		2		1				

LONG ISLAND SOUND, SURVEILLANCE SURVEY

STUDY ZONE INPUT DATA AND OUTPUT STATISTICS

Appendix L Zone 12 Long Island Sound, NY/CT

TABLE 1 Assignment of COE Waterway Codes to Subzones 8/06/91

COE Waterway		Name
Subzone 1201A		
53	A	MYSTIC RIVER, CONN.
54	A	THAMES RIVER, CONN.
56	A	CONNECTICUT RIVER BELOW HARTFORD, CONN.
63	A	HOUSATONIC RIVER, CONN.
83	A	NIANTIC BAY AND HARBOR, CONN.
215	A	GLEN COVE CREEK, N. Y.
303	A	HAY (WEST) HARBOR, N. Y.
304	A	NEW LONDON HARBOR, CONN.
311	A	BRIDGEPORT HARBOR, CONN.
313	A	WESTPORT HARBOR AND SAUGATUCK RIVER, CONN.
314	A	NORWALK HARBOR, CONN.
317	A	STAMFORD HARBOR, CONN.
319	A	GREENWICH HARBOR, CONN.
320	A	FIVEMILE RIVER HARBOR, CONN.
340	A	PORT CHESTER HARBOR, N. Y.
346	A	NEW ROCHELLE HARBOR, N. Y.
349	A	MANHASSET BAY, N. Y.
514	A	HEMPSTEAD HARBOR, N. Y.
516	A	OYSTER BAY, N. Y.
521	A	NORTHPORT HARBOR, N. Y.
522	A	PORT JEFFERSON HARBOR, N. Y.
523	A	MATTITUCK HARBOR, N. Y.
527	A	GREENPORT HARBOR, N. Y.
531	A	SAG HARBOR, N. Y.
535	A	LAKE MONTAUK HARBOR, N. Y.
1507	A	NEW HAVEN HARBOR, CONN.
Subzone 1202B		
53	A	MYSTIC RIVER, CONN.
54	A	THAMES RIVER, CONN.
56	A	CONNECTICUT RIVER BELOW HARTFORD, CONN.
63	A	HOUSATONIC RIVER, CONN.
83	A	NIANTIC BAY AND HARBOR, CONN.
215	A	GLEN COVE CREEK, N. Y.
303	A	HAY (WEST) HARBOR, N. Y.
304	A	NEW LONDON HARBOR, CONN.
311	A	BRIDGEPORT HARBOR, CONN.
313	A	WESTPORT HARBOR AND SAUGATUCK RIVER, CONN.
314	A	NORWALK HARBOR, CONN.
317	A	STAMFORD HARBOR, CONN.
319	A	GREENWICH HARBOR, CONN.
320	A	FIVEMILE RIVER HARBOR, CONN.
340	A	PORT CHESTER HARBOR, N. Y.
346	A	NEW ROCHELLE HARBOR, N. Y.
349	A	MANHASSET BAY, N. Y.
514	A	HEMPSTEAD HARBOR, N. Y.
516	A	OYSTER BAY, N. Y.
521	A	NORTHPORT HARBOR, N. Y.
522	A	PORT JEFFERSON HARBOR, N. Y.
523	A	MATTITUCK HARBOR, N. Y.
527	A	GREENPORT HARBOR, N. Y.
531	A	SAG HARBOR, N. Y.
535	A	LAKE MONTAUK HARBOR, N. Y.
1507	A	NEW HAVEN HARBOR, CONN.
Subzone 1203C		
53	A	MYSTIC RIVER, CONN.
53	B	MYSTIC RIVER, CONN.
54	A	THAMES RIVER, CONN.

TABLE 1 Assignment of COE Waterway Codes to Subzones 8/06/91

COE Waterway		Name
Subzone 1203C		
56	A	CONNECTICUT RIVER BELOW HARTFORD, CONN.
56	B	CONNECTICUT RIVER BELOW HARTFORD, CONN.
63	A	HOUSATONIC RIVER, CONN.
63	B	HOUSATONIC RIVER, CONN.
83	A	NIANTIC BAY AND HARBOR, CONN.
83	B	NIANTIC BAY AND HARBOR, CONN.
215	A	GLEN COVE CREEK, N. Y.
215	B	GLEN COVE CREEK, N. Y.
303	A	HAY (WEST) HARBOR, N. Y.
303	B	HAY (WEST) HARBOR, N. Y.
304	A	NEW LONDON HARBOR, CONN.
304	B	NEW LONDON HARBOR, CONN.
311	A	BRIDGEPORT HARBOR, CONN.
311	B	BRIDGEPORT HARBOR, CONN.
313	A	WESTPORT HARBOR AND SAUGATUCK RIVER, CONN.
313	B	WESTPORT HARBOR AND SAUGATUCK RIVER, CONN.
314	A	NORWALK HARBOR, CONN.
314	B	NORWALK HARBOR, CONN.
317	A	STAMFORD HARBOR, CONN.
317	B	STAMFORD HARBOR, CONN.
319	A	GREENWICH HARBOR, CONN.
319	B	GREENWICH HARBOR, CONN.
320	A	FIVEMILE RIVER HARBOR, CONN.
320	B	FIVEMILE RIVER HARBOR, CONN.
340	A	PORT CHESTER HARBOR, N. Y.
340	B	PORT CHESTER HARBOR, N. Y.
346	A	NEW ROCHELLE HARBOR, N. Y.
346	B	NEW ROCHELLE HARBOR, N. Y.
349	A	MANHASSET BAY, N. Y.
514	A	HEMPSTEAD HARBOR, N. Y.
514	B	HEMPSTEAD HARBOR, N. Y.
516	A	OYSTER BAY, N. Y.
516	B	OYSTER BAY, N. Y.
521	A	NORTHPORT HARBOR, N. Y.
521	B	NORTHPORT HARBOR, N. Y.
522	A	PORT JEFFERSON HARBOR, N. Y.
522	B	PORT JEFFERSON HARBOR, N. Y.
523	A	MATTITUCK HARBOR, N. Y.
523	B	MATTITUCK HARBOR, N. Y.
1507	A	NEW HAVEN HARBOR, CONN.
1507	B	NEW HAVEN HARBOR, CONN.
Subzone 1204D		
304	A	NEW LONDON HARBOR, CONN.
304	B	NEW LONDON HARBOR, CONN.
Subzone 1205D		
1507	A	NEW HAVEN HARBOR, CONN.
1507	B	NEW HAVEN HARBOR, CONN.
Subzone 1206E		
53	B	MYSTIC RIVER, CONN.
56	B	CONNECTICUT RIVER BELOW HARTFORD, CONN.
63	B	HOUSATONIC RIVER, CONN.
83	B	NIANTIC BAY AND HARBOR, CONN.
215	B	GLEN COVE CREEK, N. Y.
303	B	HAY (WEST) HARBOR, N. Y.
304	B	NEW LONDON HARBOR, CONN.

TABLE 1 Assignment of COE Waterway Codes to Subzones 8/06/91

COE Waterway		Name
Subzone 1206E		
311	B	BRIDGEPORT HARBOR, CONN.
313	B	WESTPORT HARBOR AND SAUGATUCK RIVER, CONN.
314	B	NORWALK HARBOR, CONN.
317	B	STAMFORD HARBOR, CONN.
319	B	GREENWICH HARBOR, CONN.
320	B	FIVEMILE RIVER HARBOR, CONN.
340	B	PORT CHESTER HARBOR, N. Y.
346	B	NEW ROCHELLE HARBOR, N. Y.
349	A	MANHASSET BAY, N. Y.
349	B	MANHASSET BAY, N. Y.
514	B	HEMPSTEAD HARBOR, N. Y.
516	B	OYSTER BAY, N. Y.
521	B	NORTHPORT HARBOR, N. Y.
522	B	PORT JEFFERSON HARBOR, N. Y.
523	B	MATTITUCK HARBOR, N. Y.
1507	B	NEW HAVEN HARBOR, CONN.

TABLE 2 Base Year 1987 Cargo Tons by Subzone, Commodity, and Vessel Type

Subzone 1201A

Comm. Code	Name	Dry Cargo	Tanker	Dry Cargo Barge Tow	Tanker Barge Tow	Total
1	FARM PRODUCTS	222	0	0	0	222
2	FOREST PRODUCTS	4	0	0	0	4
3	FISHERIES PRODUCTS	686	0	0	0	686
4	MINING PRODUCTS, NEC	964,380	0	225,515	0	1,189,895
5	PROC. FOODS & MFTRS, NEC	2,025,978	0	34,113	0	2,060,091
6	WASTE OF MANUFACTURING	223,391	0	7,824	0	231,215
2810	SODIUM HYDROXIDE (CAUSTI	4,495	0	0	0	4,495
2813	ALCOHOLS	0	53,755	0	8,631	62,386
2818	SULPHURIC ACID	18,799	0	0	12,004	30,803
2911	GASOLINE, INCL NATURAL	0	5,431,535	0	1,426,711	6,858,246
2912	JET FUEL	0	285,189	0	55,663	340,852
2913	KEROSENE	0	125,021	0	17,060	142,081
2914	DISTILLATE FUEL OIL	0	5,142,908	0	1,244,983	6,387,891
2915	RESIDUAL FUEL OIL	0	3,147,751	0	587,183	3,734,934
2916	LUBRIC OILS-GREASES	0	33	0	2	35
2917	NAPHTHA, PETRLM SOLVENTS	0	24,863	0	5,461	30,324
	Subzone Total :	3,237,955	14,211,055	267,452	3,357,698	21,074,160

Subzone 1202B

Comm. Code	Name	Dry Cargo	Tanker	Dry Cargo Barge Tow	Tanker Barge Tow	Total
1	FARM PRODUCTS	222	0	0	0	222
2	FOREST PRODUCTS	4	0	0	0	4
3	FISHERIES PRODUCTS	686	0	0	0	686
4	MINING PRODUCTS, NEC	964,380	0	225,515	0	1,189,895
5	PROC. FOODS & MFTRS, NEC	2,025,978	0	34,113	0	2,060,091
6	WASTE OF MANUFACTURING	223,391	0	7,824	0	231,215
2810	SODIUM HYDROXIDE (CAUSTI	4,495	0	0	0	4,495
2813	ALCOHOLS	0	53,755	0	8,631	62,386
2818	SULPHURIC ACID	18,799	0	0	12,004	30,803
2911	GASOLINE, INCL NATURAL	0	5,431,535	0	1,426,711	6,858,246
2912	JET FUEL	0	285,189	0	55,663	340,852
2913	KEROSENE	0	125,021	0	17,060	142,081
2914	DISTILLATE FUEL OIL	0	5,142,908	0	1,244,983	6,387,891
2915	RESIDUAL FUEL OIL	0	3,147,751	0	587,183	3,734,934
2916	LUBRIC OILS-GREASES	0	33	0	2	35
2917	NAPHTHA, PETRLM SOLVENTS	0	24,863	0	5,461	30,324
	Subzone Total :	3,237,955	14,211,055	267,452	3,357,698	21,074,160

TABLE 2 Base Year 1987 Cargo Tons by Subzone, Commodity, and Vessel Type

Subzone 1203C

Comm. Code	Name	Dry Cargo	Tanker	Dry Cargo Barge Tow	Tanker Barge Tow	Total
1	FARM PRODUCTS	222	0	0	0	222
2	FOREST PRODUCTS	4	0	0	0	4
3	FISHERIES PRODUCTS	686	0	0	0	686
4	MINING PRODUCTS, NEC	964,380	0	225,515	0	1,189,895
5	PROC. FOODS & MFTRS, NEC	2,025,978	0	34,113	0	2,060,091
6	WASTE OF MANUFACTURING	223,391	0	7,824	0	231,215
2810	SODIUM HYDROXIDE (CAUSTI	4,495	0	0	0	4,495
2813	ALCOHOLS	0	53,755	0	8,631	62,386
2818	SULPHURIC ACID	18,799	0	0	12,004	30,803
2911	GASOLINE, INCL NATURAL	0	5,431,535	0	1,426,711	6,858,246
2912	JET FUEL	0	285,189	0	55,663	340,852
2913	KEROSENE	0	125,021	0	17,060	142,081
2914	DISTILLATE FUEL OIL	0	5,142,908	0	1,244,983	6,387,891
2915	RESIDUAL FUEL OIL	0	3,147,751	0	587,183	[illegible] 734,934
2916	LUBRIC OILS-GREASES	0	33	0	2	35
2917	NAPHTHA, PETRLM SOLVENTS	0	24,863	0	5,461	30,324
	Subzone Total :	3,237,955	14,211,055	267,452	3,357,698	21,074,160

Subzone 1204D

Comm. Code	Name	Dry Cargo	Tanker	Dry Cargo Barge Tow	Tanker Barge Tow	Total
4	MINING PRODUCTS, NEC	25,712	0	0	0	25,712
5	PROC. FOODS & MFTRS, NEC	278,207	0	0	0	278,207
2810	SODIUM HYDROXIDE (CAUSTI	4,495	0	0	0	4,495
2818	SULPHURIC ACID	12,499	0	0	12,004	24,503
2913	KEROSENE	0	17,411	0	0	17,411
2914	DISTILLATE FUEL OIL	0	414,599	0	0	414,599
2915	RESIDUAL FUEL OIL	0	243,095	0	0	243,095
	Subzone Total :	320,913	675,105	0	12,004	1,008,022

Subzone 1205D

Comm. Code	Name	Dry Cargo	Tanker	Dry Cargo Barge Tow	Tanker Barge Tow	Total
1	FARM PRODUCTS	77	0	0	0	77
3	FISHERIES PRODUCTS	268	0	0	0	268
4	MINING PRODUCTS, NEC	30,363	0	0	0	30,363
5	PROC. FOODS & MFTRS, NEC	1,178,555	0	0	0	1,178,555
6	WASTE OF MANUFACTURING	184,423	0	0	0	184,423
2813	ALCOHOLS	0	53,755	0	8,631	62,386
2818	SULPHURIC ACID	6,300	0	0	0	6,300
2911	GASOLINE, INCL NATURAL	0	2,771,593	0	440,606	3,212,199
2912	JET FUEL	0	242,240	0	38,445	280,685
2913	KEROSENE	0	76,257	0	12,100	88,357
2914	DISTILLATE FUEL OIL	0	2,705,879	0	467,426	3,173,305
2915	RESIDUAL FUEL OIL	0	1,126,070	0	184,388	1,310,458
2917	NAPHTHA, PETRLM SOLVENTS	0	21,850	0	3,508	25,358
	Subzone Total :	1,399,986	6,997,644	0	1,155,104	9,552,734

Subzone 1206E

Comm. Code	Name	Dry Cargo	Tanker	Dry Cargo Barge Tow	Tanker Barge Tow	Total
2914	DISTILLATE FUEL OIL	0	0	0	85,064	85,064
	Subzone Total :	0	0	0	85,064	85,064

TABLE 3 Base Year (1987)
Vessel Transits by Subzone, Vessel Type, and Size.

Vessel Type	Large	Medium	Small	Total
Subzone : 1201A				
Passenger	0	0	3,912	3,912
Dry Cargo	103	545	292,763	293,411
Tanker	167	229	432	828
Dry Cargo Barge Tow	4	0	6,130	6,134
Tanker Barge Tow	407	0	1,194	1,601
Tug/Tow Boat	0	0	1,888	1,888
Subzone Total:	681	774	306,317	307,772
Subzone : 1202B				
Passenger	0	0	4,286	4,286
Dry Cargo	103	545	292,763	293,411
Tanker	167	229	432	828
Dry Cargo Barge Tow	4	0	6,130	6,134
Tanker Barge Tow	407	0	1,194	1,601
Tug/Tow Boat	0	0	1,888	1,888
Subzone Total:	681	774	306,691	308,146
Subzone : 1203C				
Passenger	0	0	18,490	18,490
Dry Cargo	103	545	41,535	42,183
Tanker	167	229	1,649	2,045
Dry Cargo Barge Tow	4	0	24,501	24,505
Tanker Barge Tow	407	0	4,487	4,894
Tug/Tow Boat	0	0	7,317	7,317
Subzone Total:	681	774	97,979	99,434
Subzone : 1204D				
Passenger	0	0	8,288	8,288
Dry Cargo	6	76	628	710
Tanker	10	41	29	80
Dry Cargo Barge Tow	0	0	142	142
Tanker Barge Tow	7	0	248	255
Tug/Tow Boat	0	0	27	27
Subzone Total:	23	117	9,362	9,502

Appendix L ZONE 12 Long Island Sound, NY/CT

TABLE 3 Base Year (1987)
Vessel Transits by Subzone, Vessel Type, and Size.

Vessel Type	Large	Medium	Small	Total
Subzone : 1205D				
Dry Cargo	56	291	709	1,056
Tanker	127	147	300	574
Dry Cargo Barge Tow	1	0	113	114
Tanker Barge Tow	243	0	1,438	1,681
Tug/Tow Boat	0	0	2,357	2,357
Subzone Total:	427	438	4,917	5,782
Subzone : 1206E				
Passenger	0	0	130	130
Tanker	0	0	1,228	1,228
Dry Cargo Barge Tow	0	0	18,374	18,374
Tanker Barge Tow	0	0	3,365	3,365
Tug/Tow Boat	0	0	5,479	5,479
Subzone Total:	0	0	28,576	28,576

Note: Sum of all vessel transits within each study subzone.

ZONE TOTALS

ZONE 12 Long Island Sound, NY/CT

Vessel Type	Large	Medium	Small	Total
Passenger	0	0	19,646	19,646
Dry Cargo	103	545	292,763	293,411
Tanker	167	229	1,657	2,053
Dry Cargo Barge Tow	4	0	24,503	24,507
Tanker Barge Tow	407	0	4,541	4,948
Tug/Tow Boat	0	0	7,355	7,355
Zone Total:	681	774	350,465	351,920

Note: Sum of all arrivals/departures to/from all terminals within the Study Zone.

TABLE 4 Barges Per Tow - Average Factors by COE Waterway 8/6/91

COE Code	Waterway Name	Dry Barge	Tank Barge
SUBZONE	All Subzones within this Zone	1	1

NOTE: Average size of tows arriving/departing terminals within the waterway. Sizes of other tows transiting the area may differ.

Appendix L Zone 12 Long Island Sound, NY/CT

TABLE 5 Other Local Vessels by Subzone 7/21/91

Subzone	Name	Number of Vessels	Vessels per Square Mile
1201A		29,440	66.61
1202B		32,250	94.85
1203C		83,890	69.33
1204D		5,459	1,186.74
1205D		10,918	992.55
1206E		18,968	790.33
	Total for Zone	180,925	89.06

Note: State registered (1989/90) vessels estimated to be operated within the Subzone.

7/24/91

Appendix L   ZONE 12 Long Island Sound, NY/CT

TABLE 6.1 Forecast 1995
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 1201A				
Passenger	0	0	3,989	3,989
Dry Cargo	134	747	308,444	309,325
Tanker	180	254	1,803	2,237
Dry Cargo Tow	0	0	25,670	25,670
Tanker Tow	426	0	4,911	5,337
Tug/Tow Boat	0	0	3,320	3,320
Subzone Total:	740	1,001	348,137	349,878
Subzone : 1202B				
Passenger	0	0	4,370	4,370
Dry Cargo	134	747	308,444	309,325
Tanker	180	254	1,803	2,237
Dry Cargo Tow	0	0	25,670	25,670
Tanker Tow	426	0	4,911	5,337
Tug/Tow Boat	0	0	3,320	3,320
Subzone Total:	740	1,001	348,518	350,259
Subzone : 1203C				
Passenger	0	0	18,853	18,853
Dry Cargo	134	747	47,141	48,022
Tanker	180	254	1,803	2,237
Dry Cargo Tow	0	0	25,669	25,669
Tanker Tow	426	0	4,911	5,337
Tug/Tow Boat	0	0	3,316	3,316
Subzone Total:	740	1,001	101,693	103,434
Subzone : 1204D				
Passenger	0	0	8,451	8,451
Dry Cargo	7	92	758	857
Tanker	11	46	32	89
Dry Cargo Tow	0	0	148	148
Tanker Tow	0	0	274	274
Tug/Tow Boat	0	0	(246)	(246)
Subzone Total:	18	138	9,417	9,573

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Appendix L ZONE 12 Long Island Sound, NY/CT

TABLE 6.1 Forecast 1995
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 1205D				
Dry Cargo	78	421	855	1,354
Tanker	135	162	318	615
Dry Cargo Tow	0	0	118	118
Tanker Tow	258	0	1,596	1,854
Tug/Tow Boat	0	0	2,892	2,892
Subzone Total:	471	583	5,779	6,833
Subzone : 1206E				
Passenger	0	0	133	133
Tanker	0	0	11	11
Dry Cargo Tow	0	0	1	1
Tanker Tow	0	0	81	81
Tug/Tow Boat	0	0	(1)	(1)
Subzone Total:	0	0	225	225

Note: Sum of all vessel transits within each study subzone.

Appendix L ZONE 12 Long Island Sound, NY/CT

TABLE 6.2 Forecast 2000
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 1201A				
Passenger	0	0	4,067	4,067
Dry Cargo	161	923	317,520	318,604
Tanker	189	270	1,907	2,366
Dry Cargo Tow	0	0	26,314	26,314
Tanker Tow	451	0	5,162	5,613
Tug/Tow Boat	0	0	4,097	4,097
Subzone Total:	801	1,193	359,067	361,061
Subzone : 1202B				
Passenger	0	0	4,456	4,456
Dry Cargo	161	923	317,520	318,604
Tanker	189	270	1,907	2,366
Dry Cargo Tow	0	0	26,314	26,314
Tanker Tow	451	0	5,162	5,613
Tug/Tow Boat	0	0	4,097	4,097
Subzone Total:	801	1,193	359,456	361,450
Subzone : 1203C				
Passenger	0	0	19,224	19,224
Dry Cargo	161	923	51,043	52,127
Tanker	189	270	1,907	2,366
Dry Cargo Tow	0	0	26,313	26,313
Tanker Tow	451	0	5,162	5,613
Tug/Tow Boat	0	0	4,093	4,093
Subzone Total:	801	1,193	107,742	109,736
Subzone : 1204D				
Passenger	0	0	8,617	8,617
Dry Cargo	8	104	852	964
Tanker	12	49	35	96
Dry Cargo Tow	0	0	151	151
Tanker Tow	0	0	291	291
Tug/Tow Boat	0	0	(247)	(247)
Subzone Total:	20	153	9,699	9,872

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Appendix L ZONE 12 Long Island Sound, NY/CT

TABLE 6.2 Forecast 2000
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 1205D				
Dry Cargo	99	542	968	1,609
Tanker	142	173	334	649
Dry Cargo Tow	0	0	120	120
Tanker Tow	272	0	1,709	1,981
Tug/Tow Boat	0	0	3,469	3,469
Subzone Total:	513	715	6,600	7,828
Subzone : 1206E				
Passenger	0	0	135	135
Tanker	0	0	12	12
Dry Cargo Tow	0	0	1	1
Tanker Tow	0	0	87	87
Tug/Tow Boat	0	0	(1)	(1)
Subzone Total:	0	0	234	234

Note: Sum of all vessel transits within each study subzone.

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Appendix L ZONE 12 Long Island Sound, NY/CT

TABLE 6.3 Forecast 2005
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 1201A				
Passenger	0	0	4,164	4,164
Dry Cargo	197	1,162	326,812	328,171
Tanker	200	286	2,016	2,502
Dry Cargo Tow	0	0	26,962	26,962
Tanker Tow	478	0	5,425	5,903
Tug/Tow Boat	0	0	5,130	5,130
Subzone Total:	875	1,448	370,509	372,832
Subzone : 1202B				
Passenger	0	0	4,562	4,562
Dry Cargo	197	1,162	326,812	328,171
Tanker	200	286	2,016	2,502
Dry Cargo Tow	0	0	26,962	26,962
Tanker Tow	478	0	5,425	5,903
Tug/Tow Boat	0	0	5,130	5,130
Subzone Total:	875	1,448	370,907	373,230
Subzone : 1203C				
Passenger	0	0	19,680	19,680
Dry Cargo	197	1,162	55,335	56,694
Tanker	200	286	2,016	2,502
Dry Cargo Tow	0	0	26,961	26,961
Tanker Tow	478	0	5,425	5,903
Tug/Tow Boat	0	0	5,126	5,126
Subzone Total:	875	1,448	114,543	116,866
Subzone : 1204D				
Passenger	0	0	8,821	8,821
Dry Cargo	9	118	960	1,087
Tanker	13	52	37	102
Dry Cargo Tow	0	0	153	153
Tanker Tow	0	0	310	310
Tug/Tow Boat	0	0	(248)	(248)
Subzone Total:	22	170	10,033	10,225

Appendix L ZONE 12 Long Island Sound, NY/CT

TABLE 6.3 Forecast 2005
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 1205D				
Dry Cargo	127	713	1,108	1,948
Tanker	150	184	350	684
Dry Cargo Tow	0	0	122	122
Tanker Tow	287	0	1,830	2,117
Tug/Tow Boat	0	0	4,252	4,252
Subzone Total:	564	897	7,662	9,123
Subzone : 1206E				
Passenger	0	0	138	138
Tanker	0	0	12	12
Dry Cargo Tow	0	0	1	1
Tanker Tow	0	0	93	93
Tug/Tow Boat	0	0	(1)	(1)
Subzone Total:	0	0	243	243

Note: Sum of all vessel transits within each study subzone.

Appendix L ZONE 12 Long Island Sound, NY/CT

TABLE 6.4 Forecast 2010
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 1201A				
Passenger	0	0	4,263	4,263
Dry Cargo	247	1,489	336,586	338,322
Tanker	214	307	2,136	2,657
Dry Cargo Tow	0	0	27,634	27,634
Tanker Tow	507	0	5,705	6,212
Tug/Tow Boat	0	0	6,527	6,527
Subzone Total:	968	1,796	382,851	385,615
Subzone : 1202B				
Passenger	0	0	4,670	4,670
Dry Cargo	247	1,489	336,586	338,322
Tanker	214	307	2,136	2,657
Dry Cargo Tow	0	0	27,634	27,634
Tanker Tow	507	0	5,705	6,212
Tug/Tow Boat	0	0	6,527	6,527
Subzone Total:	968	1,796	383,258	386,022
Subzone : 1203C				
Passenger	0	0	20,147	20,147
Dry Cargo	247	1,489	60,059	61,795
Tanker	214	307	2,136	2,657
Dry Cargo Tow	0	0	27,633	27,633
Tanker Tow	507	0	5,705	6,212
Tug/Tow Boat	0	0	6,523	6,523
Subzone Total:	968	1,796	122,203	124,967
Subzone : 1204D				
Passenger	0	0	9,031	9,031
Dry Cargo	11	135	1,082	1,228
Tanker	14	56	40	110
Dry Cargo Tow	0	0	156	156
Tanker Tow	0	0	330	330
Tug/Tow Boat	0	0	(249)	(249)
Subzone Total:	25	191	10,390	10,606

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Appendix L   ZONE 12 Long Island Sound, NY/CT

TABLE 6.4 Forecast 2010
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 1205D				
Dry Cargo	167	955	1,282	2,404
Tanker	159	197	369	725
Dry Cargo Tow	0	0	124	124
Tanker Tow	303	0	1,959	2,262
Tug/Tow Boat	0	0	5,333	5,333
Subzone Total:	629	1,152	9,067	10,848
Subzone : 1206E				
Passenger	0	0	142	142
Tanker	0	0	12	12
Dry Cargo Tow	0	0	1	1
Tanker Tow	0	0	100	100
Tug/Tow Boat	0	0	(1)	(1)
Subzone Total:	0	0	254	254

Note: Sum of all vessel transits within each study subzone.

Appendix L ZONE 1 Long Island Sound, NY/CT

TABLE 6.5 Forecast 1995 - 2010 Vessel Transits by Vessel Type and Size

Vessel Type	Large	Medium	Small	Total
1995 FORECASTED ZONE TOTALS				
Passenger	0	0	20,032	20,032
Dry Cargo	125	699	308,331	309,155
Tanker	180	254	1,803	2,237
Dry Cargo Tow	0	0	25,670	25,670
Tanker Tow	426	0	4,911	5,337
Tug/Tow Boat	0	0	3,320	3,320
1995 Zone Total:	731	953	364,067	365,751
2000 FORECASTED ZONE TOTALS				
Passenger	0	0	20,426	20,426
Dry Cargo	145	831	317,321	318,297
Tanker	189	270	1,907	2,366
Dry Cargo Tow	0	0	26,314	26,314
Tanker Tow	451	0	5,162	5,613
Tug/Tow Boat	0	0	4,097	4,097
2000 Zone Total:	785	1,101	375,227	377,113
2005 FORECASTED ZONE TOTALS				
Passenger	0	0	20,910	20,910
Dry Cargo	178	1,025	326,544	327,747
Tanker	200	286	2,016	2,502
Dry Cargo Tow	0	0	26,962	26,962
Tanker Tow	478	0	5,425	5,903
Tug/Tow Boat	0	0	5,130	5,130
2005 Zone Total:	856	1,311	386,987	389,154
2010 FORECASTED ZONE TOTALS				
Passenger	0	0	21,406	21,406
Dry Cargo	223	1,314	336,283	337,820
Tanker	214	307	2,136	2,657
Dry Cargo Tow	0	0	27,634	27,634
Tanker Tow	507	0	5,705	6,212
Tug/Tow Boat	0	0	6,527	6,527
2010 Zone Total:	944	1,621	399,691	402,256

Note: Sum of all arrivals/departures to/from all terminals within the study zone.

TABLE 7 Vessel Casualty History (10 Year Totals) by Subzone, Vessel Type and Size, and Casualty Type

Vessel Type	Size	Collisions	Rammings	Groundings	Other	Total
Subzone: 1201A						
Passenger	Small	1	0	24	0	25
Fishing	Small	3	0	2	0	5
Other	Small	1	0	0	0	1
Subzone Totals:		5	0	26	0	31
Subzone: 1202B						
Passenger	Small	0	0	2	0	2
Fishing	Small	0	0	1	0	1
Subzone Totals:		0	0	3	0	3
Subzone: 1203C						
Passenger	Small	2	0	1	0	3
Tanker	Large	0	0	1	0	1
Dry Cargo Barge Tow	Small	1	0	0	0	1
Tanker Barge Tow	Small	3	0	2	0	5
Other	Small	2	0	1	0	3
Subzone Totals:		8	0	5	0	13
Subzone: 1205D						
Tanker Barge Tow	Small	0	0	1	0	1
Subzone Totals:		0	0	1	0	1
Subzone: 1206E						
Tanker Barge Tow	Small	0	0	2	0	2
Tug/Tow Boat	Small	0	0	1	0	1
Subzone Totals:		0	0	3	0	3
Zone Totals:		13	0	38	0	51

Note: OTHER equals barge breakaways and weather caused vessel casualties.

APPENDIX TABLE L-8 ZONE 12, LONG ISLAND, NY - VTS LEVELS IN OPERATION

(Not Applicable to This Sub-Zone.)

APPENDIX TABLE L-9 ZONE 12, LONG ISLAND, NY
CANDIDATE VTS DESIGN - 1995-2010

UNITS

1	Radar Module 1	- Average Performance
0	Radar Module 2	- Average Performance
2	Radar Module 3	- High Performance
0	Radar Module 4	- High Performance
0	Radar Module 5	- Special Purpose
0	Radar Module 6	- Special Purpose
0	ADS Module 7	- Active Radar Transponder (Type 1)
0	ADS Module 8	- Positional Transponder, Small Area, Very High Accuracy (Type 5)
0	ADS Module 9	- Positional Transponder, Small Area, High Accuracy (Type 6)
5	VHF Module 10	- Low power VHF Transmitting/ Receiving Facility
2	VHF Module 11	- High power VHF Transmitting/ Receiving Facility
0	Meteorological Module 12	- Air temperature, wind direction and speed
2	Meteorological Module 13	- Air temperature, wind direction and speed, visibility
0	Hydrological Module 14	- Water Temperature and Depth
1	Hydrological Module 15	- Water Temperature, Depth and Current
0	VHF/DF MODULE 16	- Line of position measurement to 2 degree RMS
0	CCTV MODULE 17	- Fixed Focus CCTV via Telephone Lines
0	CCTV MODULE 18	- Remotely Controllable CCTV via

Appendix L Zone 12 Long Island Sound, NY/CT

TABLE 10A Avoided Vessel Casualties 1996 - 2010 Candidate VTS Systems 7/31/91

Counts

Vessel Type	Size	Collision	Ramming	Grounding	Total
Passenger	Small	.29	.05	.43	.76
Dry Cargo	Large	.05	.01	.10	.16
Dry Cargo	Medium	.13	.02	.07	.22
Dry Cargo	Small	3.17	.42	.84	4.43
Tanker	Large	.13	.03	.25	.41
Tanker	Medium	.02	.00	.02	.04
Tanker	Small	.11	0.00	.10	.21
Dry Cargo Barge T	Small	9.57	3.09	4.60	17.26
Tanker Barge Tow	Large	.09	.05	.08	.22
Tanker Barge Tow	Small	2.06	.38	1.66	4.10
Tug/Tow Boat	Small	.15	.06	.15	.36
		15.76	4.12	8.31	28.19

Undiscounted Total Dollar Losses (1,000)

Vessel Type	Size	Collision	Ramming	Grounding	Total
Passenger	Small	255	44	266	565
Dry Cargo	Large	80	21	32	133
Dry Cargo	Medium	200	49	23	271
Dry Cargo	Small	2,219	292	524	3,035
Tanker	Large	535	156	607	1,298
Tanker	Medium	35	5	11	51
Tanker	Small	49	0	26	75
Dry Cargo Barge T	Small	525	331	75	931
Tanker Barge Tow	Large	568	320	373	1,261
Tanker Barge Tow	Small	6,182	1,167	866	8,215
Tug/Tow Boat	Small	12	9	11	32
		10,660	2,394	2,813	15,867

Note: In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 11 Avoided Fatalities 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Small	.02	.00	.03	.05
Dry Cargo	Large	.01	.00	.01	.02
Dry Cargo	Medium	.02	.00	.01	.03
Dry Cargo	Small	.20	.03	.05	.28
Tanker	Small	.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	.02	.01	.01	.04
Tanker Barge Tow	Small	.00	.00	.00	.01
Tug/Tow Boat	Small	.00	.00	.00	.00
Totals		.27	.04	.12	.43
Candidate VTS Design - Dollars					
Passenger	Small	27,686.71	4,768.13	40,820.61	73,275.45
Dry Cargo	Large	10,183.70	2,034.37	18,397.98	30,616.05
Dry Cargo	Medium	23,578.23	4,460.45	13,682.91	41,721.59
Dry Cargo	Small	304,557.21	40,123.07	80,650.59	425,330.88
Tanker	Small	361.31	0.00	340.24	701.55
Dry Cargo Barge Tow	Small	31,628.04	10,215.99	15,219.55	57,063.59
Tanker Barge Tow	Small	6,805.91	1,267.12	5,480.81	13,553.84
Tug/Tow Boat	Small	498.97	189.93	508.47	1,197.37
Totals		405,300.08	63,059.06	175,101.17	643,460.31

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 12 Avoided Human Injuries 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Small	.22	.04	.32	.58
Dry Cargo	Large	.00	.00	.00	.00
Dry Cargo	Medium	.00	.00	.00	.00
Dry Cargo	Small	2.41	.32	.64	3.36
Tanker	Small	.00	0.00	.00	.01
Dry Cargo Barge Tow	Small	.23	.07	.11	.42
Tanker Barge Tow	Small	.05	.01	.04	.10
Tug/Tow Boat	Small	.00	.00	.00	.01
Totals		2.92	.44	1.12	4.48
Candidate VTS Design - Dollars					
Passenger	Small	52,134.53	8,978.47	76,865.89	137,978.89
Dry Cargo	Large	174.85	34.93	315.89	525.67
Dry Cargo	Medium	404.83	76.58	234.93	716.35
Dry Cargo	Small	573,486.29	75,552.41	151,866.40	800,905.10
Tanker	Small	631.32	0.00	594.50	1,225.82
Dry Cargo Barge Tow	Small	55,264.12	17,850.55	26,593.34	99,708.01
Tanker Barge Tow	Small	11,892.06	2,214.06	9,576.70	23,682.82
Tug/Tow Boat	Small	871.86	331.87	888.45	2,092.18
Totals		694,859.87	105,038.87	266,936.10	1,066,834.84

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 13 Avoided Vessels Damaged 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Small	.25	.03	.13	.41
Dry Cargo	Large	.04	.01	.01	.06
Dry Cargo	Medium	.09	.02	.01	.12
Dry Cargo	Small	2.72	.29	.44	3.45
Tanker	Large	.10	.03	.03	.16
Tanker	Medium	.02	.00	.00	.02
Tanker	Small	.02	0.00	.02	.05
Dry Cargo Barge Tow	Small	7.30	1.31	.64	9.25
Tanker Barge Tow	Large	.08	.02	.02	.12
Tanker Barge Tow	Small	1.57	.16	.23	1.96
Tug/Tow Boat	Small	.03	.01	.02	.05
Totals		12.21	1.88	1.56	15.64
Candidate VTS Design - Dollars					
Passenger	Small	83,762.83	11,275.11	68,429.26	163,467.20
Dry Cargo	Large	29,599.51	5,658.72	5,665.65	40,923.88
Dry Cargo	Medium	82,793.24	14,988.99	3,150.33	100,932.56
Dry Cargo	Small	515,978.35	55,273.77	112,950.23	684,202.35
Tanker	Large	74,943.13	21,618.68	71,626.61	168,188.42
Tanker	Medium	11,211.92	1,311.36	4,706.80	17,230.08
Tanker	Small	7,160.49	0.00	8,795.22	15,955.71
Dry Cargo Barge Tow	Small	423,895.16	75,815.64	32,568.52	532,279.32
Tanker Barge Tow	Large	13,014.29	3,947.11	3,351.51	20,312.91
Tanker Barge Tow	Small	111,440.25	11,488.55	20,836.54	143,765.34
Tug/Tow Boat	Small	1,903.85	465.46	1,886.49	4,255.80
Totals		1,355,703.00	201,843.40	333,967.15	1,891,513.55

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 14 Avoided Cargo Damage/Loss 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Small	.06	.01	.04	.11
Dry Cargo	Large	.01	.00	.01	.03
Dry Cargo	Medium	.03	.01	.01	.05
Dry Cargo	Small	1.01	.12	.17	1.30
Tanker	Large	.03	.01	.02	.07
Tanker	Medium	.01	.00	.00	.01
Tanker	Small	.02	0.00	.01	.03
Dry Cargo Tow	Small	1.35	.44	.26	2.05
Tanker Tow	Large	.01	.00	.01	.02
Tanker Tow	Small	.29	.05	.10	.44
Tug/Tow Boat	Small	.01	.00	.01	.02
Totals		2.83	.65	.63	4.11
Candidate VTS Design - Dollars					
Passenger	Small	211.83	28.51	154.54	394.88
Dry Cargo	Large	152.39	43.13	26.04	221.56
Dry Cargo	Medium	352.84	94.57	19.36	466.77
Dry Cargo	Small	2,341.65	250.85	507.02	3,099.52
Tanker	Large	2,267.90	623.51	3,748.27	6,639.68
Tanker	Medium	87.68	10.10	27.00	124.79
Tanker	Small	64.01	0.00	47.18	111.18
Tanker Tow	Large	3,180.74	1,753.94	2,902.54	7,837.22
Tanker Tow	Small	27,710.96	5,127.07	8,916.78	41,754.82
Tug/Tow Boat	Small	22.92	5.60	22.10	50.62
Totals		36,392.92	7,937.28	16,370.84	60,701.04

Note1: Dollar values include bulk petroleum and chemical cargos only and all vessel fuels spilled. Dollar values exclude cargo loss/damage for non-tank vessel types.

Note2: In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding

TABLE 15 Avoided NavAid Damage 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Small	0.00	.01	.00	.01
Dry Cargo	Large	0.00	.00	.00	.00
Dry Cargo	Medium	0.00	.00	.00	.00
Dry Cargo	Small	0.00	.05	.00	.05
Tanker	Large	0.00	.00	.00	.01
Tanker	Medium	0.00	.00	.00	.00
Tanker	Small	0.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	0.00	.35	.03	.38
Tanker Barge Tow	Large	0.00	.01	.00	.01
Tanker Barge Tow	Small	0.00	.04	.01	.05
Tug/Tow Boat	Small	0.00	.01	.00	.01
Totals		0.00	.47	.05	.52
Candidate VTS Design - Dollars					
Passenger	Small	0.00	32.06	13.74	45.80
Dry Cargo	Large	0.00	6.98	3.16	10.14
Dry Cargo	Medium	0.00	15.31	2.35	17.66
Dry Cargo	Small	0.00	269.75	27.14	296.89
Tanker	Large	0.00	22.19	8.20	30.39
Tanker	Medium	0.00	1.60	.65	2.24
Tanker	Small	0.00	0.00	3.33	3.33
Dry Cargo Barge Tow	Small	0.00	1,995.03	148.79	2,143.82
Tanker Barge Tow	Large	0.00	31.28	2.71	33.99
Tanker Barge Tow	Small	0.00	247.45	53.58	301.03
Tug/Tow Boat	Small	0.00	37.09	4.97	42.06
Totals		0.00	2,658.74	268.62	2,927.36

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal place . Counts totals were calculated before rounding.

TABLE 16 Avoided Bridge Damage 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Small	.00	.00	0.00	.00
Dry Cargo	Large	0.00	.00	0.00	.00
Dry Cargo	Medium	0.00	.00	0.00	.00
Dry Cargo	Small	.00	.02	0.00	.02
Tanker	Large	0.00	.00	0.00	.00
Tanker	Medium	0.00	.00	0.00	.00
Tanke	Small	.00	0.00	0.00	.00
Dry Cargo Barge Tow	Small	.01	.11	0.00	.12
Tanker Barge Tow	Large	0.00	.01	0.00	.01
Tanker Barge Tow	Small	.00	.01	0.00	.02
Tug/Tow Boat	Small	.00	.00	0.00	.00
Totals		.01	.16	0.00	.17
Candidate VTS Design - Dollars					
Passenger	Small	762.24	5,932.84	0.00	6,695.08
Dry Cargo	Large	0.00	2,254.32	0.00	2,254.32
Dry Cargo	Medium	0.00	4,938.66	0.00	4,938.66
Dry Cargo	Small	5,578.53	33,051.86	0.00	38,630.39
Tanker	Large	0.00	7,133.13	0.00	7,133.13
Tanker	Medium	0.00	513.89	0.00	513.89
Tanker	Small	162.78	0.00	0.00	162.78
Dry Cargo Barge Tow	Small	14,290.12	225,423.84	0.00	239,713.96
Tanker Barge Tow	Large	0.00	10,127.39	0.00	10,127.39
Tanker Barge Tow	Small	3,033.83	27,620.26	0.00	30,654.09
Tug/Tow Boat	Small	331.75	5,866.23	0.00	6,197.98
Totals		24,159.25	322,862.42	0.00	347,021.67

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

Appendix L Zone 12 Long Island Sound, NY/CT
TABLE 17 Avoided Hazardous Commodity Spills 1996 - 2010 7/30/91

Commodity	Catastrophic	Large	Medium	Small	Total
Candidate Vts Design - Counts					
ALCOHOLS	.00	.00	.00	.00	.00
KEROSENE	.00	.00	.00	.00	.00
JET FUEL	.00	.00	.00	.00	.00
RESIDUAL FUEL OIL	.00	.01	.05	.07	.12
GASOLINE, INCL NATURAL	.00	.01	.01	.00	.02
DISTILLATE FUEL OIL	.01	.09	.23	.87	1.20
	.02	.11	.28	.94	1.35

Note: In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

Appendix L
TABLE 18A

Zone 12 Long Island Sound, NY/CT
Annual Benefit & Cost Streams
Candidate VTS Systems

7/31/91

Discounted to 1993

Year	Investment ($1,000)	Operation & Maintenance ($1,000)	Benefits ($1,000)
1993	5,706	0	0
1996	0	404	772
1997	0	367	709
1998	0	334	651
1999	0	303	598
2000	0	276	550
2001	0	251	505
2002	0	228	464
2003	0	207	426
2004	0	188	392
2005	0	171	360
2006	0	156	331
2007	0	142	304
2008	0	129	280
2009	0	117	257
2010	0	106	237
	5,706	3,378	6,837

Undiscounted

Year	Investment ($1,000)	Operation & Maintenance ($1,000)	Benefits ($1,000)
1993	5,706	0	0
1996	0	513	981
1997	0	513	991
1998	0	513	1,001
1999	0	513	1,011
2000	0	513	1,022
2001	0	513	1,033
2002	0	513	1,044
2003	0	513	1,055
2004	0	513	1,067
2005	0	513	1,079
2006	0	513	1,091
2007	0	513	1,103
2008	0	513	1,116
2009	0	513	1,129
2010	0	513	1,143
	5,706	7,695	15,867

APPENDIX L

ZONE 12 - LONG ISLAND SOUND, NY

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Long Island Sound	(Port 12)			Wildlife Abundance Tables Fish & Shellfish Grams per Square Meter			
Port & Subzone	Species Category	Species Code	Species Name	Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
1201	101	1	American Shad	.0043	.0043	.0043	.0043
1201	101	2	Alewife	.2100	.2100	.2100	.2100
1201	102	3	Atl.Menhaden	5.5000	5.5000	5.5000	0.0000
1201	102	4	Atl.Herring	.3919	0.0000	0.0000	.3919
1201	102	5	Butterfish	.3036	.3036	.3036	.3036
1201	102	7	Atlantic Mackerel	2.9000	2.9000	2.9000	2.9000
1201	102	32	King Mackerel	.0190	.0370	.0190	0.0000
1201	102	44	Striped Mullet	.0480	.0480	.0480	.0480
1201	102	127	Silversides	4.0000	5.0000	7.8000	7.8000
1201	103	8	Bluefish	0.0000	2.7419	2.7419	0.0000
1201	103	9	Striped Bass	.0047	.4700	.0094	.0094
1201	103	10	Monkfish	.0770	.0770	.0770	.0770
1201	103	11	Weakfish	0.0000	2.3503	2.3503	0.0000
1201	104	13	Swordfish	.0330	.0330	.0330	.0330
1201	104	14	Shark	.0041	.0041	.0041	.0041
1201	104	15	Dogfish	.9900	.9900	.9900	.9900
1201	105	16	Yellowtail Flounder	1.6655	1.6655	0.0000	0.0000
1201	105	17	Summer Flounder	.0940	.0940	.0940	.0940
1201	105	20	Winter Flounder	1.8614	1.8614	1.8614	1.8614
1201	105	251	Windowpane Flounder	1.4695	1.4695	0.0000	0.0000
1201	106	25	Red Hake	.1959	.1959	.1959	.1959
1201	106	27	Scup	0.0000	.1958	.1958	0.0000
1201	106	28	Tilefish	.0330	.0330	.0330	.0330
1201	106	29	Black Sea Bass	.0300	.0300	.0300	.0300
1201	106	35	Croaker	.0470	.0470	.0470	.0470
1201	106	109	Long Horned Sculpin	3.0370	0.0000	0.0000	3.0370
1201	106	116	Little Skate	7.2497	7.2497	7.2497	4.2497
1201	106	116	Winter Skate	8.8173	0.0000	0.0000	8.8173
1201	106	199	Other	0.0000	15.0498	33.0995	15.0498
1201	106	254	Ocean Pout	.1959	.1959	.1959	.1959
1201	107	201	Surf Clam	1.2000	1.2000	1.2000	1.2000
1201	107	202	Quahog	7.2000	7.2000	7.2000	7.2000
1201	107	203	Atlantic Sea Scallop	.0600	.0600	.0600	.0600
1201	107	299	Other Invertebrates	.0480	.0480	.0480	.0480
1201	108	204	American Lobster	.1959	.1959	.1959	.1959
1201	108	206	Red Crab	.2300	.2300	.2300	.2300
1201	109	207	Long Fin Squid	.6200	2.6440	2.6440	.6200
1202	101	1	American Shad	.0043	.0043	.0043	.0043
1202	101	2	Alewife	.2100	.2100	.2100	.2100
1202	102	3	Atl.Menhaden	5.5000	5.5000	5.5000	0.0000
1202	102	4	Atl.Herring	.3919	0.0000	0.0000	.3919
1202	102	5	Butterfish	.3036	.3036	.3036	.3036
1202	102	7	Atlantic Mackerel	2.9000	2.9000	2.9000	2.9000
1202	102	32	King Mackerel	.0190	.0370	.0190	0.0000
1202	102	44	Striped Mullet	.0480	.0480	.0480	.0480
1202	102	127	Silversides	4.0000	5.0000	7.8000	7.8000
1202	103	8	Bluefish	0.0000	2.7419	2.7419	0.0000
1202	103	9	Striped Bass	.0047	.4700	.0094	.0094
1202	103	10	Monkfish	.0770	.0770	.0770	.0770
1202	103	11	Weakfish	0.0000	2.3503	2.3503	0.0000
1202	104	13	Swordfish	.0330	.0330	.0330	.0330
1202	104	14	Shark	.0041	.0041	.0041	.0041
1202	104	15	Dogfish	.9900	.9900	.9900	.9900

APPENDIX L

ZONE 12 - LONG ISLAND SOUND, NY (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Long Island Sound	(Port 12)			Wildlife Abundance Tables Fish & Shellfish Grams per Square Meter			
Port & Subzone	Species Category	Species Code	Species Name	Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
1202	105	16	Yellowtail Flounder	1.6655	1.6655	0.0000	0.0000
1202	105	17	Summer Flounder	.0940	.0940	.0940	.0940
1202	105	20	Winter Flounder	1.8614	1.8614	1.8614	1.8614
1202	105	251	Windowpane Flounder	1.4695	1.4695	0.0000	0.0000
1202	106	25	Red Hake	.1959	.1959	.1959	.1959
1202	106	27	Scup	0.0000	.1958	.1958	0.0000
1202	106	28	Tilefish	.0330	.0330	.0330	.0330
1202	106	29	Black Sea Bass	.0300	.0300	.0300	.0300
1202	106	35	Croaker	.0470	.0470	.0470	.0470
1202	106	109	Long Horned Sculpin	3.0370	0.0000	0.0000	3.0370
1202	106	116	Little Skate	7.2497	7.2497	7.2497	4.2497
1202	106	116	Winter Skate	8.8173	0.0000	0.0000	8.8173
1202	106	199	Other	0.0000	15.0498	33.0995	15.0498
1202	106	254	Ocean Pout	.1959	.1959	.1959	.1959
1202	107	201	Surf Clam	1.2000	1.2000	1.2000	1.2000
1202	107	202	Quahog	7.2000	7.2000	7.2000	7.2000
1202	107	203	Atlantic Sea Scallop	.0600	.0600	.0600	.0600
1202	107	299	Other Invertebrates	.0480	.0480	.0480	.0480
1202	108	204	American Lobster	.1959	.1959	.1959	.1959
1202	108	206	Red Crab	.2300	.2300	.2300	.2300
1202	109	207	Long Fin Squid	.6200	2.6440	2.6440	.6200
1203	101	1	American Shad	.1200	.0580	0.0000	.0580
1203	101	2	Alewife	.4100	.4100	.4100	.4100
1203	101	31	Hickory Shad	.0120	.0060	0.0000	.0060
1203	102	3	Menhaden	22.1000	22.4000	11.2000	0.0000
1203	102	4	Atlantic Herring	.0010	.0010	.0010	.0010
1203	102	7	Atlantic Mackerel	.0040	0.0000	0.0000	.0040
1203	102	32	King Mackerel	.0030	0.0000	0.0000	.0030
1203	102	33	Spanish Mackerel	.0210	0.0000	0.0000	.0210
1203	102	34	Harvestfish	.0010	.0010	.0010	.0010
1203	103	8	Bluefish	.2700	.3200	.3200	0.0000
1203	103	9	Striped Bass	.2600	.4700	.4200	.4200
1203	103	11	Weakfish	.3100	.3100	.3100	.0070
1203	105	17	Summer Flounder	.0280	.0280	.0280	.0280
1203	105	18	American Plaice	.0170	.0090	.0090	.0100
1203	105	20	Winter Flounder	6.4585	6.4585	6.4585	6.4585
1203	106	24	Silver Hake	.0010	.0010	.0010	.0010
1203	106	25	Red Hake	.0040	.0020	.0030	.0030
1203	106	26	White Hake	.0090	.0140	.0050	0.0000
1203	106	29	Black Sea Bass	.0010	.0010	.0010	.0010
1203	106	35	Atlantic Croaker	.3700	.3700	.3700	0.0000
1203	106	36	Drum	.0020	.0020	.0020	0.0000
1203	106	37	Spot	.0960	.0490	0.0000	.0490
1203	106	38	Yellow Perch	.0020	.0020	.0020	.0020
1203	106	39	Carp	.0250	.0250	.0250	.0250
1203	106	40	Eel	.1400	.1400	.1400	.1400
1203	106	199	Other	.7800	.7800	.7800	.7800
1203	107	211	Soft Clam	.1700	.1700	.1700	.1700
1203	107	212	Oyster	1.9000	1.9000	1.9000	1.9000
1203	107	213	Hard Clam	.0800	.0800	.0800	.0800
1203	107	214	Conch	.0660	.0660	.0660	.0660
1203	108	204	American Lobster	2.5543	2.5543	2.5543	2.5543
1203	108	209	Hard Blue Crab	4.1000	4.1000	4.1000	4.1000

ZONE 12 - LONG ISLAND SOUND, NY (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Long Island Sound Port & Subzone	Species Category	(Port 12) Species Code	Species Name	Wildlife Abundance Tables Fish & Shellfish Grams per Square Meter Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
1203	108	210	Soft Blue Crab	.2000	.2000	0.0000	0.0000
1203	109	207	Squid	.0280	.1500	.1300	0.0000
1204	101	1	American Shad	.1200	.0580	0.0000	.0580
1204	101	2	Alewife	.4100	.4100	.4100	.4100
1204	101	31	Hickory Shad	.0120	.0060	0.0000	.0060
1204	102	3	Menhaden	22.1000	22.4000	11.2000	0.0000
1204	102	4	Atlantic Herring	.0010	.0010	.0010	.0010
1204	102	7	Atlantic Mackerel	.0040	0.0000	0.0000	.0040
1204	102	32	King Mackerel	.0030	0.0000	0.0000	.0030
1204	102	33	Spanish Mackerel	.0210	0.0000	0.0000	.0210
1204	102	34	Harvestfish	.0010	.0010	.0010	.0010
1204	103	8	Bluefish	.2700	.3200	.3200	0.0000
1204	103	9	Striped Bass	.2600	.4700	.4200	.4200
1204	103	11	Weakfish	.3100	.3100	.3100	.0070
1204	105	17	Summer Flounder	.0280	.0280	.0280	.0280
1204	105	18	American Plaice	.0170	.0090	.0090	.0100
1204	105	20	Winter Flounder	6.4585	6.4585	6.4585	6.4585
1204	106	24	Silver Hake	.0010	.0010	.0010	.0010
1204	106	25	Red Hake	.0040	.0020	.0030	.0030
1204	106	26	White Hake	.0090	.0140	.0050	0.0000
1204	106	29	Black Sea Bass	.0010	.0010	.0010	.0010
1204	106	35	Atlantic Croaker	.3700	.3700	.3700	0.0000
1204	106	36	Drum	.0020	.0020	.0020	0.0000
1204	106	37	Spot	.0960	.0490	0.0000	.0490
1204	106	38	Yellow Perch	.0020	.0020	.0020	.0020
1204	106	39	Carp	.0250	.0250	.0250	.0250
1204	106	40	Eel	.1400	.1400	.1400	.1400
1204	106	199	Other	.7800	.7800	.7800	.7800
1204	107	211	Soft Clam	.1700	.1700	.1700	.1700
1204	107	212	Oyster	1.9000	1.9000	1.9000	1.9000
1204	107	213	Hard Clam	.0800	.0800	.0800	.0800
1204	107	214	Conch	.0660	.0660	.0660	.0660
1204	108	204	American Lobster	2.5543	2.5543	2.5543	2.5543
1204	108	209	Hard Blue Crab	4.1000	4.1000	4.1000	4.1000
1204	108	210	Soft Blue Crab	.2000	.2000	0.0000	0.0000
1204	109	207	Squid	.0280	.1500	.1300	0.0000
1205	101	1	American Shad	.1200	.0580	0.0000	.0580
1205	101	2	Alewife	.4100	.4100	.4100	.4100
1205	101	31	Hickory Shad	.0120	.0060	0.0000	.0060
1205	102	3	Menhaden	22.1000	22.4000	11.2000	0.0000
1205	102	4	Atlantic Herring	.0010	.0010	.0010	.0010
1205	102	7	Atlantic Mackerel	.0040	0.0000	0.0000	.0040
1205	102	32	King Mackerel	.0030	0.0000	0.0000	.0030
1205	102	33	Spanish Mackerel	.0210	0.0000	0.0000	.0210
1205	102	34	Harvestfish	.0010	.0010	.0010	.0010
1205	103	8	Bluefish	.2700	.3200	.3200	0.0000
1205	103	9	Striped Bass	.2600	.4700	.4200	.4200
1205	103	11	Weakfish	.3100	.3100	.3100	.0070
1205	105	17	Summer Flounder	.0280	.0280	.0280	.0280
1205	105	18	American Plaice	.0170	.0090	.0090	.0100
1205	105	20	Winter Flounder	6.4585	6.4585	6.4585	6.4585
1205	106	24	Silver Hake	.0010	.0010	.0010	.0010
1205	106	25	Red Hake	.0040	.0020	.0030	.0030

APPENDIX L

ZONE 12 - LONG ISLAND SOUND, NY (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Long Island Sound (Port 12) Port & Subzone	Species Category	Species Code	Species Name	Wildlife Abundance Tables Fish & Shellfish Grams per Square Meter Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
1205	106	26	White Hake	.0090	.0140	.0050	0.0000
1205	106	29	Black Sea Bass	.0010	.0010	.0010	.0010
1205	106	35	Atlantic Croaker	.3700	.3700	.3700	0.0000
1205	106	36	Drum	.0020	.0020	.0020	0.0000
1205	106	37	Spot	.0960	.0490	0.0000	.0490
1205	106	38	Yellow Perch	.0020	.0020	.0020	.0020
1205	106	39	Carp	.0250	.0250	.0250	.0250
1205	106	40	Eel	.1400	.1400	.1400	.1400
1205	106	199	Other	.7800	.7800	.7800	.7800
1205	107	211	Soft Clam	.1700	.1700	.1700	.1700
1205	107	212	Oyster	1.9000	1.9000	1.9000	1.9000
1205	107	213	Hard Clam	.0800	.0800	.0800	.0800
1205	107	214	Conch	.0660	.0660	.0660	.0660
1205	108	204	American Lobster	2.5543	2.5543	2.5543	2.5543
1205	108	209	Hard Blue Crab	4.1000	4.1000	4.1000	4.1000
1205	108	210	Soft Blue Crab	.2000	.2000	0.0000	0.0000
1205	109	207	Squid	.0280	.1500	.1300	0.0000
1206	101	1	American Shad	.1200	.5800	0.0000	.0580
1206	101	2	Alewife	.4100	.4100	.4100	.4100
1206	101	31	Hickory Shad	.0120	.0060	0.0000	.0060
1206	102	3	Menhaden	21.1000	22.4000	11.2000	0.0000
1206	102	4	Atlantic Herring	.0010	.0010	.0010	.0010
1206	102	7	Atlantic Mackerel	.0040	0.0000	0.0000	.0040
1206	102	32	King Mackerel	.0030	0.0000	0.0000	.0030
1206	102	33	Spanish Mackerel	.0210	0.0000	0.0000	.0211
1206	102	34	Harvestfish	.0010	.0010	.0010	.0010
1206	103	8	Bluefish	.2700	.3200	.3200	0.0000
1206	103	9	Striped Bass	.2600	.4700	.4200	.4200
1206	103	11	Weakfish	.3100	.3100	.3100	.0070
1206	106	24	Silver Hake	.0010	.0010	.0010	.0010
1206	106	25	Red Hake	.0040	.0020	.0030	.0030
1206	106	26	White Hake	.0090	.0140	.0050	0.0000
1206	106	29	Black Sea Bass	.0010	.0010	.0010	.0010
1206	106	35	Atlantic Croaker	.3700	.3700	.3700	0.0000
1206	106	36	Drum	.0020	.0020	.0020	0.0000
1206	106	37	Spot	.0960	.0490	0.0000	.0490
1206	106	38	Yellow Perch	.0020	.0020	.0020	.0020
1206	106	39	Carp	.0250	.0250	.0250	.0250
1206	106	40	Eel	.1400	.1400	.1400	.1400
1206	106	67	Tautaug	1.1000	1.1000	1.1000	1.1000
1206	106	199	Other	.7800	.7800	.7800	.7800
1206	107	212	Oyster	1.9000	1.9000	1.9000	1.9000
1206	107	214	Conch	.0660	.0660	.0660	.0660
1206	108	209	Hard Blue Crab	4.1000	4.1000	4.1000	4.1000
1206	108	210	Soft Blue Crab	.2000	.2000	0.0000	0.0000
1206	109	207	Squid	.0280	.1500	.1300	0.0000

APPENDIX L

ZONE 12 - LONG ISLAND SOUND, NY (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Long Island Sound	(Port 12)			Wildlife Abundance Tables Fish & Shellfish Larvae Numbers per Square Meter			
Port & Subzone	Species Category	Species Code	Species Name	Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
1201	202	1003	Atlantic Menhaden	0.0000	0.0000	0.0000	5.5000
1201	202	1004	Atlantic Herring	0.0000	0.0000	.5000	.2000
1201	202	1005	Butterfish	0.0000	5.0000	0.0000	0.0000
1201	202	1007	Atlantic Mackerel	55.0000	0.0000	0.0000	0.0000
1201	202	1043	Anchovy	0.0000	10.0000	0.0000	0.0000
1201	202	1110	Sand Lance	5.0000	0.0000	5.0000	55.0000
1201	203	1199	Larvae	.0110	.1900	.0054	0.0000
1201	205	1016	Yellow Tail Flounder	5.5000	0.0000	0.0000	0.0000
1201	205	1017	Summer Flounder	0.0000	0.0000	2.5000	0.0000
1201	205	1019	Witchflounder	.5000	0.0000	0.0000	0.0000
1201	205	1251	Four Spot Flounder	1.6500	1.6500	1.6500	0.0000
1201	205	1251	Gulf Stream Flounder	0.0000	1.0000	0.0000	0.0000
1201	205	1251	Windowpane	0.0000	5.0000	5.0000	0.0000
1201	206	1021	Atlantic Cod	.5000	0.0000	0.0000	0.0000
1201	206	1022	Haddock	.5000	0.0000	0.0000	0.0000
1201	206	1024	Silver Hake	10.0000	5.0000	0.0000	0.0000
1201	206	1025	Hakes	0.0000	5.0000	0.0000	0.0000
1201	206	1027	Scup	0.0000	.2900	.2900	0.0000
1201	206	1040	Cusk Eel	.3400	.3400	.3400	0.0000
1201	206	1112	Seasnail	.2300	.2300	.2300	0.0000
1201	206	1255	Conner	0.0000	55.0000	0.0000	0.0000
1201	207	1199	Larvae	2.0000	20.0000	2.0000	0.0000
1201	208	1204	Lobster	0.0000	.0052	0.0000	0.0000
1202	202	1003	Menhaden	.0667	1.3330	2.1667	0.0000
1202	202	1004	Herring	0.0000	0.0000	0.0000	.0438
1202	202	1043	Anchovy	0.0000	49.0833	.1667	0.0000
1202	202	1127	Silverside	.0333	0.0000	0.0000	0.0000
1202	202	1128	Northern Searobin	.1667	.2500	0.0000	0.0000
1202	203	1010	Monkfish	.5000	.0833	.0417	0.0000
1202	203	1011	Weakfish	.6667	.6667	0.0000	0.0000
1202	205	1016	Yellowtail Flounder	.0750	0.0000	0.0000	0.0000
1202	205	1251	Four Spot Flounder	0.0000	0.0000	.0075	0.0000
1202	206	1027	Scup	.1667	.1667	0.0000	0.0000
1202	206	1040	American Eel	0.0000	0.0000	0.0000	.1667
1202	206	1109	Sculpin	.2500	0.0000	0.0000	.0833
1202	206	1244	Northern Pipefish	.0833	.0833	0.0000	0.0000
1202	206	1252	Rockling	.3917	0.0000	0.0000	0.0000
1202	206	1255	Conner	0.0000	1.0000	.1667	0.0000
1202	207	1199	Larvae	2.0000	20.0000	2.0000	0.0000
1202	208	1199	Larvae	.0016	.0042	0.0000	0.0000
1203	202	1003	Menhaden	.0667	1.3330	2.1667	0.0000
1203	202	1004	Herring	0.0000	0.0000	0.0000	.0438
1203	202	1043	Anchovy	0.0000	49.0833	.1667	0.0000
1203	202	1110	Sand Lance	2.0000	0.0000	.4167	15.6875
1203	202	1110	Sand Lance	9.3406	0.0000	54.3976	88.7882
1203	202	1127	Silverside	.0333	0.0000	0.0000	0.0000
1203	202	1128	Northern Searobin	.1667	.2500	0.0000	0.0000
1203	203	1010	Monkfish	.5000	.0833	.0417	0.0000
1203	203	1011	Weakfish	.6667	.6667	0.0000	0.0000
1203	205	1016	Yellowtail Flounder	.0750	0.0000	0.0000	0.0000
1203	205	1251	Four Spot Flounder	0.0000	0.0000	.0075	0.0000
1203	206	1027	Scup	.1667	.1667	0.0000	0.0000
1203	206	1040	American Eel	0.0000	0.0000	0.0000	.1667
1203	206	1109	Sculpin	.[illegible]500	0.0000	0.0000	.0833

ZONE 12 - LONG ISLAND SOUND, NY (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Long Island Sound Port & Subzone	Species Category	(Port 12) Species Code	Species Name	Wildlife Abundance Tables Fish & Shellfish Larvae Numbers per Square Meter Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
1203	206	1244	Northern Pipefish	.0833	.0833	0.0000	0.0000
1203	206	1252	Rockling	.3917	0.0000	0.0000	0.0000
1203	206	1255	Conner	0.0000	1.0000	.1667	0.0000
1203	207	1199	Larvae	2.0000	20.0000	2.0000	0.0000
1203	208	1199	Larvae	.0016	.0042	0.0000	0.0000
1204	202	1199	Larvae	.1900	.8100	.8100	.2200
1204	203	1199	Larvae	.0110	.1900	.0054	0.0000
1204	205	1199	Larvae	1.1000	.6600	.3600	.0040
1204	206	1199	Larvae	.0270	.4700	1.0400	.0200
1204	207	1199	Larvae	2.0000	20.0000	2.0000	0.0000
1204	208	1199	Larvae	.0016	.0042	0.0000	0.0000
1205	202	1199	Larvae	.1900	.8100	.8100	.2200
1205	203	1199	Larvae	.0110	.1900	.0054	0.0000
1205	205	1199	Larvae	1.1000	.6600	.3600	.0040
1205	206	1199	Larvae	.0270	.4700	1.0400	.0200
1205	207	1199	Larvae	2.0000	20.0000	2.0000	0.0000
1205	208	1199	Larvae	.0016	.0042	0.0000	0.0000
1206	202	1199	Larvae	.1900	.8100	.8100	.2200
1206	203	1199	Larvae	.0110	.1900	.0054	0.0000
1206	205	1199	Larvae	1.1000	.6600	.3600	.0040
1206	206	1199	Larvae	.0270	.4700	1.0400	.0200
1206	207	1199	Larvae	2.0000	20.0000	2.0000	0.0000
1206	208	1199	Larvae	.0016	.0042	0.0000	0.0000

ZONE 12 - LONG ISLAND SOUND, NY (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Long Island Sound	(Port 12)			Wildlife Abundance Tables Birds Numbers per Square Kilometer			
Port & Subzone	Species Category	Species Code	Species Name	Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
1201	111	514	Swans	0.0000	0.0000	0.0000	.0157
1201	111	517	Common Loon	.0600	0.0000	.0200	.0200
1201	111	517	Loons	.0800	0.0000	.0300	.0200
1201	111	517	Red Throated Loon	.0200	0.0000	.0100	0.0000
1201	111	537	Storm Petrels	1.0600	5.7400	.0200	0.0000
1201	112	571	Sandpiper,Plover,Turnstone	.0002	0.0000	0.0000	.0354
1201	112	572	Oystercatcher,Avocet,Stilt	0.0000	.0001	0.0000	0.0000
1201	113	530	Cormorant	7.2932	10.4188	0.0000	0.0000
1201	113	531	Gulls	8.8900	.8300	4.2300	8.7300
1201	113	531	Herring Gulls	39.3518	24.0741	41.6667	94.4400
1201	113	531	Laughing Gulls	0.0000	.2778	1.2500	.2778
1201	113	531	Ring Billed Gulls	2.5463	.9259	2.2685	2.7778
1201	113	532	Black Legged Kittiwake	.3200	0.0000	.5000	1.1100
1201	113	533	Terns	.1900	.0200	.0100	0.0000
1201	113	534	Audubons Shearwater	0.0000	.0500	.0100	0.0000
1201	113	534	Cory's Shearwater	.0100	2.0000	.4400	0.0000
1201	113	534	Greater Shearwater	.2400	2.8100	4.0900	.0100
1201	113	534	Manx Sherwater	0.0000	.0100	.0100	0.0000
1201	113	534	Sooty Shearwater	.1300	.6300	.0100	.0100
1201	113	535	Other Jaeger	.0100	.0100	.0200	.0100
1201	113	535	Parasitic Jaeger	0.0000	0.0000	.0100	0.0000
1201	113	535	Pomarine Jaeger	0.0000	.0200	.1200	.0100
1201	113	535	Skua	.0100	.0100	.0100	.0100
1201	113	536	Northern Fulmar	.9100	.0100	.0700	2.8100
1201	113	537	White Faced Storm Petrel	0.0000	0.0000	.0100	0.0000
1201	113	538	Dovekie	.0100	0.0000	0.0000	.0100
1201	113	538	Large Alcid	.0500	0.0000	.0100	.0700
1201	113	538	Murre	.0100	0.0000	0.0000	.0400
1201	113	538	Razorbill	.0500	0.0000	0.0000	.1600
1201	113	540	Atlantic Puffin	.0100	.0100	0.0000	0.0000
1201	113	542	Other Phalarope	.0700	.0200	.0100	0.0000
1201	113	542	Red Necked Phalarope	0.0000	.0100	0.0000	0.0000
1201	113	542	Red Phalarope	.9200	.0400	.4800	0.0000
1201	113	543	Albatross	0.0000	.0100	0.0000	0.0000
1201	113	547	Northern Gannet	1.1800	.0100	.3300	1.6000
1201	114	583	Hawks	0.0000	0.0000	0.0000	.0010
1201	114	584	Owls	0.0000	0.0000	0.0000	.0010
1202	111	511	Dabbling Ducks	276.1296	847.1110	1243.8778	240.7222
1202	111	513	Geese	.5209	0.0000	0.0000	0.0000
1202	111	514	Swans	0.0000	0.0000	0.0000	.0157
1202	111	517	Common Loon	.0600	0.0000	.0200	.0200
1202	111	517	Loons	.0800	0.0000	.0300	.0200
1202	111	517	Red Throated Loon	.0200	0.0000	.0100	0.0000
1202	111	537	Storm Petrels	1.0600	5.7400	.0200	0.0000
1202	112	571	Sandpiper,Plover,Turnstone	.0002	0.0000	0.0000	.0354
1202	112	572	Oystercatcher,Avocet,Stilt	0.0000	.0001	0.0000	0.0000
1202	113	530	Cormorant	7.2932	10.4188	0.0000	0.0000
1202	113	531	Gulls	8.8900	.8300	4.2300	8.7300
1202	113	531	Herring Gulls	39.3518	24.0741	41.6667	94.4400
1202	113	531	Laughing Gulls	0.0000	.2778	1.2500	.2778
1202	113	531	Ring Billed Gulls	2.5463	.9259	2.2685	2.7778
1202	113	532	Black Legged Kittiwake	.3200	0.0000	.5000	1.1100
1202	113	533	Terns	.1900	.0200	.0100	0.0000
1202	113	534	Audubons Shearwater	0.0000	.0500	.0100	0.0000
1202	113	534	Cory's Shearwater	.0100	2.0000	.4400	0.0000

ZONE 12 - LONG ISLAND SOUND, NY (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Wildlife Abundance Tables
Birds
Numbers per Square Kilometer

Long Island Sound (Port 12)

Port & Subzone	Species Category	Species Code	Species Name	Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
1202	113	534	Greater Shearwater	.2400	2.8100	4.0900	.0100
1202	113	534	Manx Sherwater	0.0000	.0100	.0100	0.0000
1202	113	534	Sooty Shearwater	.1300	.6300	.0100	.0100
1202	113	535	Other Jaeger	.0100	.0100	.0200	.0100
1202	113	535	Parasitic Jaeger	0.0000	0.0000	.0100	0.0000
1202	113	535	Pomarine Jaeger	0.0000	.0200	.1200	.0100
1202	113	535	Skua	.0100	.0100	.0100	.0100
1202	113	536	Northern Fulmar	.9100	.0100	.0700	2.8100
1202	113	537	White Faced Storm Petrel	0.0000	0.0000	.0100	0.0000
1202	113	538	Dovekie	.0100	0.0000	0.0000	.0100
1202	113	538	Large Alcid	.0500	0.0000	.0100	.0700
1202	113	538	Murre	.0100	0.0000	0.0000	.0400
1202	113	538	Razorbill	.0500	0.0000	0.0000	.1600
1202	113	540	Atlantic Puffin	.0100	.0100	0.0000	0.0000
1202	113	542	Other Phalarope	.0700	.0200	.0100	0.0000
1202	113	542	Red Necked Phalarope	0.0000	.0100	0.0000	0.0000
1202	113	542	Red Phalarope	.9200	.0400	.4800	0.0000
1202	113	543	Albatross	0.0000	.0100	0.0000	0.0000
1202	113	547	Northern Gannet	1.1800	.0100	.3300	1.6000
1202	114	583	Hawks	0.0000	0.0000	0.0000	.0010
1202	114	584	Owls	0.0000	0.0000	0.0000	.0010
1203	111	511	Duck	160.0000	0.0000	160.0000	320.0000
1203	111	512	Coot	1.6000	0.0000	1.6000	3.1000
1203	111	513	Goose	205.0000	0.0000	205.0000	410.0000
1203	111	514	Swan	20.0000	20.0000	20.0000	20.0000
1203	112	570	Shore Birds	376.0000	144.6000	94.8000	11.7000
1203	113	530	Sea Birds	20.3000	7.6000	8.1000	9.9000
1203	114	581	Osprey	10.4600	10.4600	10.4600	10.4600
1204	111	511	Duck	160.0000	0.0000	160.0000	320.0000
1204	111	512	Coot	1.6000	0.0000	1.6000	3.1000
1204	111	513	Goose	205.0000	0.0000	205.0000	410.0000
1204	111	514	Swan	20.0000	20.0000	20.0000	20.0000
1204	112	570	Shore Birds	376.0000	144.6000	94.8000	11.7000
1204	113	530	Sea Birds	20.3000	7.6000	8.1000	9.9000
1204	114	581	Osprey	10.4600	10.4600	10.4600	10.4600
1205	111	511	Duck	160 0000	0.0000	160.0000	320.0000
1205	111	512	Coot	1.6000	0.0000	1.6000	3.1000
1205	111	513	Goose	205.0000	0.0000	205.0000	410.0000
1205	111	514	Swan	20.0000	20.0000	20.0000	20.0000
1205	112	570	Shore Birds	376.0000	144.6000	94.8000	11.7000
1205	113	530	Sea Birds	20.3000	7.6000	8.1000	9.9000
1205	114	581	Osprey	10.4600	10.4600	10.4600	10.4600
1206	111	511	Duck	160.0000	0.0000	160.0000	320.0000
1206	111	512	Coot	1.6000	0.0000	1.6000	3.1000
1206	111	513	Goose	205.0000	0.0000	205.0000	410.0000
1206	111	514	Swan	20.0000	20.0000	20.0000	20.0000
1206	112	570	Shore Birds	376.0000	144.6000	94.8000	11.7000
1206	113	530	Sea Birds	20.3000	7.6000	8.1000	9.9000
1206	114	581	Osprey	10.4600	10.4600	10.4600	10.4600

APPENDIX M

PHILADELPHIA/DELAWARE BAY, PA

(ZONE 13)

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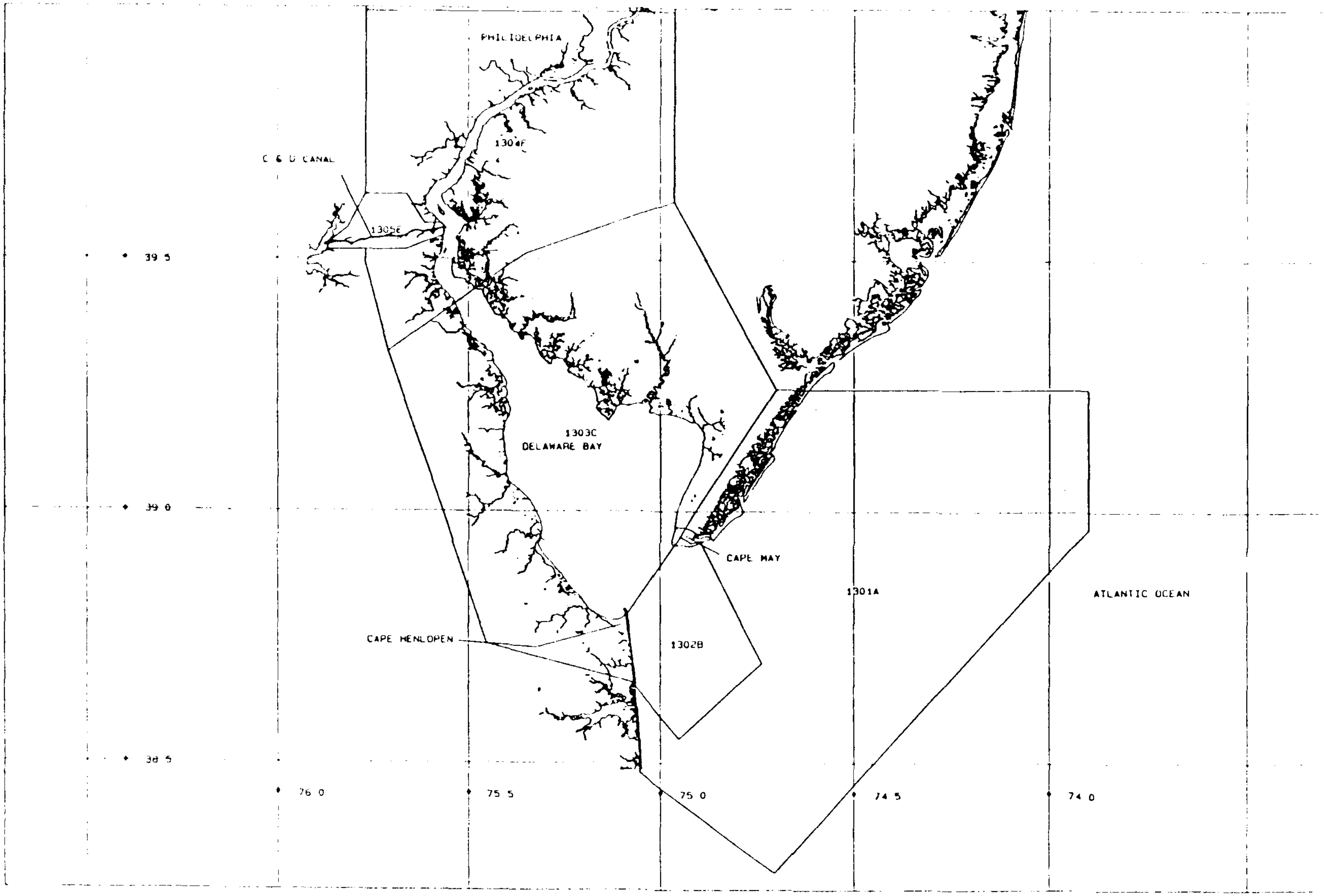
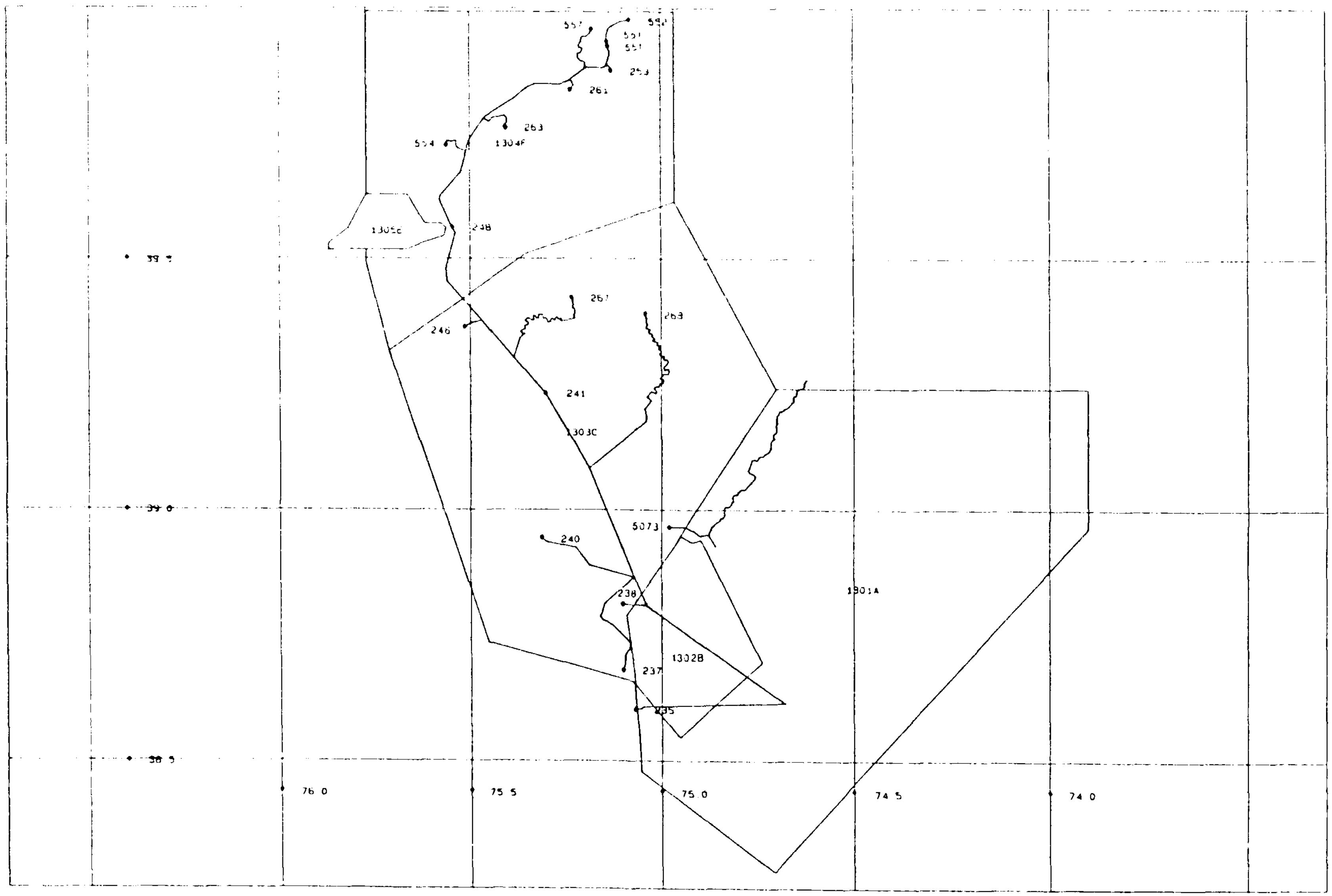
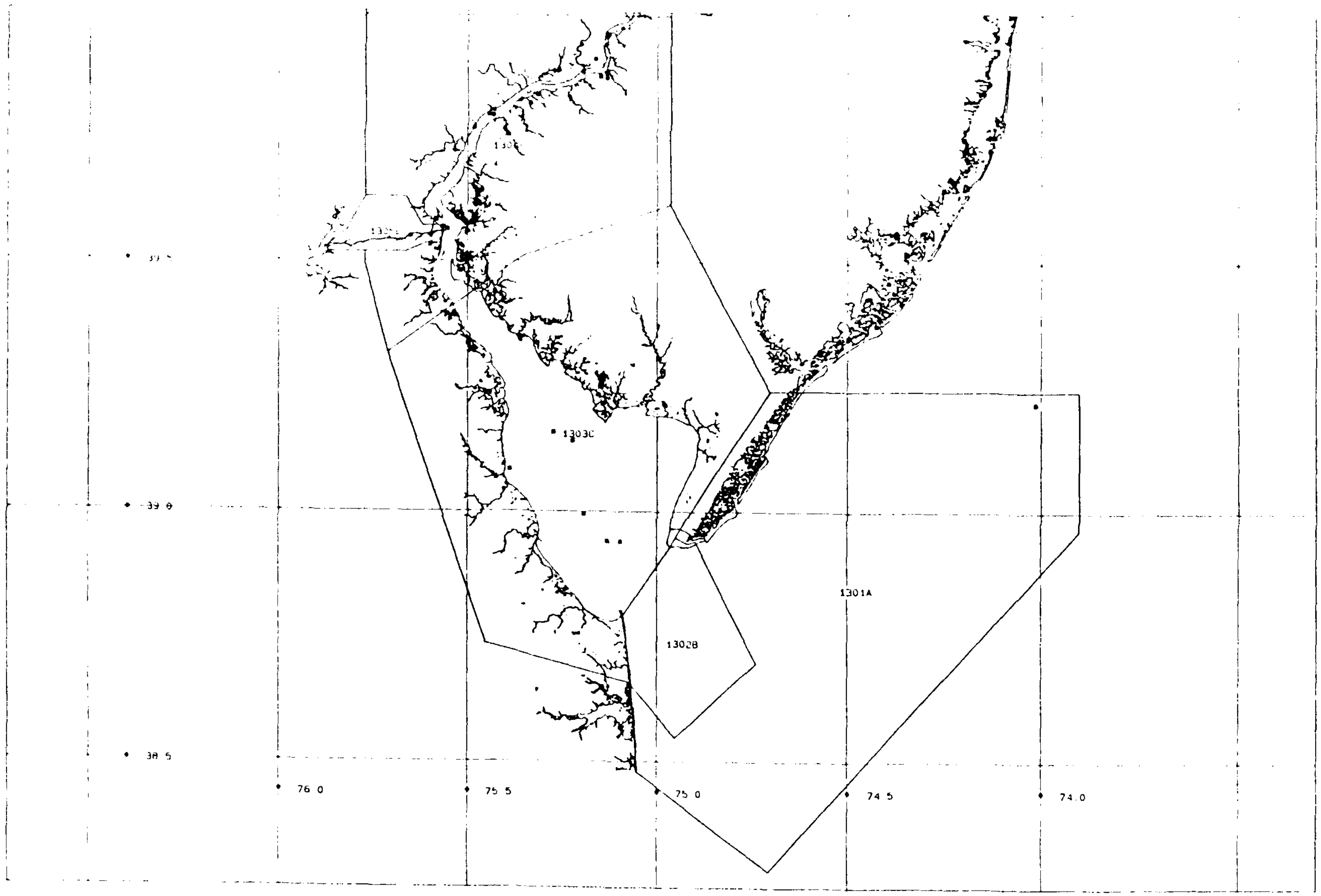
STUDY ZONE MAPS



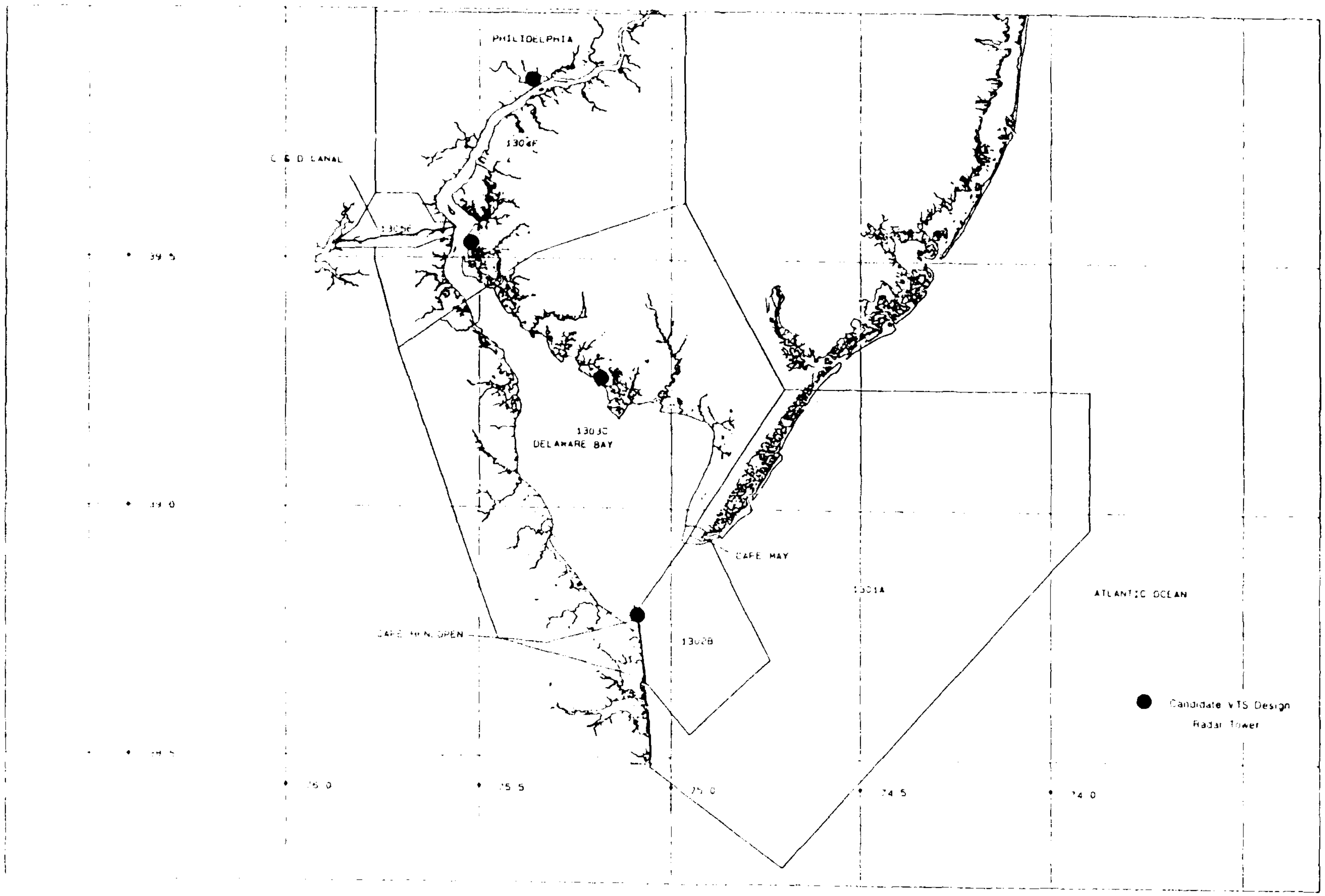
ZONE 13 - PHILADELPHIA/DELAWARE BAY, PA - ZONE AND SUBZONE BOUNDARIES



ZONE 13 - PHILADELPHIA/DELAWARE BAY, PA - DOMINANT VESSEL ROUTES AND COE WATERWAY CODES



ZONE 13 - PHILADELPHIA/DELAWARE BAY, PA - BASE PERIOD (10 YEAR) VESSEL CASUALTIES



ZONE 13 - PHILADELPHIA/DELAWARE BAY, PA - CANDIDATE VTS DESIGN RADAR LOCATIONS

CANDIDATE VTS DESIGN REPORT

FOR

PHILADELPHIA/DELAWARE BAY, PA

(ZONE 13)

Prepared for:
U.S. Department of Transportation
Research and Special Programs Administration
John A. Volpe National Transportation Systems Center
Cambridge, MA 02142

Prepared by:
NAVCOM Systems, Inc.,
7203 Gateway Court
Manassas, VA 22110

July 1991

OVERVIEW

The Candidate VTS Design described in this appendix is one of 23 developed for all the study zones included in the study. This appendix documents the task performed, under Contract DTRS-57-88-C-00088 Technical Task Directive 13, as an integral part of the total Port Needs Study. The ultimate product of this task effort is an informed preliminary technical assessment of the approximate cost to the Federal Government to implement and operate a state-of-the-art VTS system. This appendix does not contain a comprehensive definition of the VTS operating requirements nor does it propose a final VTS specification suitable for implementation.

In order to consistently estimate the life cycle costs of a VTS system in each of the study zones, a "Candidate VTS Design" has been defined for each study zone using a uniform set of design criteria. Each study zone Candidate VTS Design is a composite of generic modules selected from a master list of 18 state-of-the-art surveillance modules, communications and display technology. Among the surveillance modules in the master list are several levels of technical performance from which the selection is made for application to each study subzone to address the local navigational surveillance needs and conditions. The Candidate VTS Design in each study zone represents a consistent application of the surveillance modules at the subzone level. The subzone surveillance technology is subsequently integrated into a total system for the study zone via state-of-the-art communications and display consoles at the Vessel Traffic Center (VTC) in each zone.

The application of the surveillance modules in each subzone responds to the technical requirements of that subzone as perceived by the study team. The Candidate VTS Design represents a preliminary engineering judgement on the appropriate level of technology in each subzone. The Candidate VTS Design may be considered as an informed judgement made by the contractor study team for the sole purpose of developing cost estimates that are consistent across the 23 study zones and suitable for benefit/cost comparisons among the study zones and initial budget planning and implementation priorities. The approach used to calculate VTS system costs for all 23 study zones is found in Volume III, Technical Supplement.

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APPENDIX

PORT OF PHILADELPHIA VTS SURVEY

1.0 SCOPE

This report includes a port survey and a VTS design for the Port of Philadelphia. The port survey is based on a review of all pertinent literature including navigational charts. The methodology used to produce the VTS design entails coupling the problems identified in the port survey with solutions offered by state-of-the-art technology as identified in the VTS Technology Survey, November 1990. When possible, technological advances which permit manpower reductions are applied. Not all VTS problems are amenable to strictly technological solutions; some require changes in procedures and/or enforcement. These situations are identified where they occur.

2.0 PHILADELPHIA PORT SURVEY

2.1 INTRODUCTION

This survey report is based exclusively upon review of available literature and examination of the charts for the area and its approaches. The information thus gained has been evaluated and interpreted based upon the Survey Team's experience as professional mariners and in vessel traffic management systems.

The Survey Area embraces the Port of Philadelphia consisting of that portion of the Delaware River from Fort Mifflin on the south to Poquessing Creek on the north (about 20 miles) and the Schuylkill River within the municipality of Philadelphia. Philadelphia is among the major ports of the United States, handling a significant volume of both general cargo and petrochemicals. As in any narrow, busy, confined channel, the potential for multiship incident is appreciable. Given that the entire Delaware and Schuylkill Rivers area is environmentally sensitive the consequences of an incident can be substantial.

2.2 OVERVIEW OF THE PORT

Climate within the Survey Area is generally mild, with little or no impact upon the movement of ships within the Study Area.

The diurnal tidal range is about 5.9 feet, with currents substantially affected by river runoffs. Even at flood stages commercial traffic in the rivers is little affected.

Entrance to the Port is via the Delaware or Schuylkill Rivers. Both consist largely of improved channels. A federal project provides for a channel 40 feet deep from the sea to the Philadelphia Naval Shipyard, thence a split-depth 37/40 feet channel to Allegheny Avenue. From Allegheny Avenue to the U. S. Steel turning basin opposite Newbold Avenue a depth of 40 feet is maintained and above that to Trenton the channel is 25 feet. Actual dimensions

and depths should be taken from the tabulations of the latest charts.

Pilotage on the Delaware River is compulsory for all foreign-flag ships and U. S.-flag ships under register in the foreign trade, and optional for U. S.-flag ships in the coastwise trade with a federally licensed pilot on board. Pilot service is provided by the Pilots Association for the Bay and River of Delaware, the Chesapeake and Interstate Pilots Association (federal pilots) and the Interport Pilots Agency (federal pilots).

The Pilots Association for the Bay and River of Delaware board inbound ships at the entrance to Delaware Bay. The pilot station at Cape Henlopen and the pilot boats guard VHF-FM channels 14 and 16, and the pilots themselves carry portable transceivers for CH13.

The Chesapeake and Interstate Pilots Association requires that arrangements for pilotage be made at least 12 hours in advance. The pilot boat guards CH16, beginning two hours in advance of scheduled arrival, and uses CH7 or CH14 as a working frequency.

The Interport Pilots Agency also requires advance arrangement. They use the same pilot boat as the Chesapeake and Interstate Pilots Association, and frequency arrangements are the same.

2.3 EXISTING TRAFFIC MANAGEMENT

2.3.1 Philadelphia Marine Exchange

The Philadelphia Marine Exchange maintains a central port operation and ship reporting service for the Port of Philadelphia, using VHF-FM and visual reporting stations. Information as to position, estimated time of arrival, docking and similar information can be transmitted to and received from the Marine Exchange on VHF-FM CH14.

2.3.2 Harbor Regulations

Local rules and regulations are enforced by the Navigation Commission for the Delaware River, and copies of the regulations may be obtained from the Commission's office in Philadelphia. Generally, the regulations focus on dockside procedures more than on navigation and traffic management.

2.4 VESSEL TRAFFIC

The Center for Marine Conservation statistics for 1987 do not highlight Philadelphia but combine its shipping with that of the Greater Delaware River area. The Delaware River had 2443 tank ship movements that year, and 5683 tank barge movement (Reference 1).

No significant information about vessel movement statistics was provided by the TSC Trip Report.

2.5 ENVIRONMENTAL SENSITIVITY

The entire Delaware and Schuylkill Rivers complex is considered environmentally sensitive. A "worst case" scenario is one involving tank rupture as the result of a collision with a tank ship or barge. Unless containment is rapid and effective, the pollutant will be carried throughout the lower river. Because of its concentrated population, "worse case" in terms of human health probably is an incident involving release of toxic chemicals or gases.

2.6 PORT SUB-ZONES

The Study Area was examined to determine appropriate sub-zones, using the methodology based upon the "confined-complex", "open-complex", "confined-simple" and "open-simple" system employed by the Canadian VTS Study in 1984 (Reference 2). Briefly stated, "open" and "confined" address the influence of geography upon a ship's ability to maneuver; and "simple" vs "complex" is descriptive of the nature of the interactions between ships within those geographic areas. This basic matrix was overlaid by a subjective assessment of appropriate traffic management/risk amelioration measures in order to derive sub-zones within which VTS needs are homogeneous, or nearly so.

2.6.1 Sub-Zone I -- Lower Delaware River (NOAA Chart 12312)

The Sub-Zone consists of that portion of the Delaware River lying southwestward of 75^0-19'W.

The sub-zone functions essentially as a data catchment area for shipping entering the Philadelphia VTS Zone from the lower Delaware River. The principal function of the VTS within the sub-zone is thus to establish communications with inbound traffic and obtain information about characteristics, intentions and movements.

The sub-zone is "confined-complex."

2.6.2 Sub-Zone II -- Upper Delaware River (NOAA Chart 12314)

The sub-zone consists of that portion of the Delaware River east of 74^0 -58'W.

The sub-zone functions essentially as a data catchment area for shipping entering the Philadelphia VTS Zone from the upper Delaware River. The principal function of the VTS within the sub-zone is thus to establish communications with inbound traffic and obtain information about characteristics, intentions and movements.

The sub-zone is "confined-complex."

2.6.3 Sub-Zone III -- Philadelphia (NOAA Chart 12312, 12313 & 12314)

The sub-zone consists of the Delaware River between the boundary of Sub-Zone I (75^0-19'W) and the boundary of Sub-Zone II (74^0 -58'W). It includes the Schuylkill River to the University Avenue Bridge.

The sub-zone contains several anchorages which require management, and traffic within the sub-zone is both heavy and diversified. There are a number of bridge crossings and places where visibility is obscured or limited by bends.

The sub-zone is "confined-complex."

2.7 PROBLEM AREA IDENTIFIERS (TABLE 2-1)

The junction of the Schuylkill and Delaware Junctions can be a point of congestion at which movement management advice is required. The channel width makes navigational assistance impractical but along-track movement is important to queuing when that is required.

3.0 PORT OF PHILADELPHIA VTS DESIGN

3.1 INTRODUCTION

A detailed survey of the Port of Philadelphia is the basis for this design. An approach to costing VTS systems is outlined in Vol. III, Technical Supplement and a method of categorizing surveillance sensors into "modules" has also been developed. These modules are defined in terms of cost and performance and are to be applied to all VTS designs in this study. The applicability of Automatic Dependent Surveillance (ADS) technology is also discussed in this report. The three sub-zones defined in the harbor survey remain the same.

The hardware and software selected for this design provide the level of surveillance justified by the problems identified in each sub-zone. A secondary consideration is to locate all VTS assets so that they are sufficient for the sub-zone in question and can contribute to adjoining sub-zones to achieve maximum usage. All specific equipments are then selected based on perceived surveillance requirements and overall VTS system architecture.

TABLE 2-1. PHILADELPHIA/DELAWARE BAY, PA
PROBLEM AREA IDENTIFIERS

PAI	LOCATION	PROBLEM	MANAGEMENT
I	Lower Delaware River	Data catchment area for inbound shipping	Have knowledge of vessel movements, locations through reporting. Enter inbound shipping information into database.
II	Upper Delaware River	Data catchment area for inbound shipping	Same As Above.
III	Philadelphia Bay	Potential congestion, bridge crossings, obscured visibility	Have real-time knowledge of vessel movements and locations. Provide movement management advice and anchorage management.

3.1.1 VTS Design Approach

The choice of surveillance sensors is dependent on the VTS mission. For the purposes of this design, the VTS mission is defined as that which insures the safety of navigation and the protection of the environment. In order to accomplish this mission, mandatory participation of all vessels over 20 meters is essential. The Vessel Traffic Center (VTC) must provide navigation safety advice to all vessels. The VTS in the United States will have no facilitation of commerce role nor will it offer piloting assistance of any kind.

The primary criteria for selection of adequate surveillance sensors are:

- o Percentage of vessels of the desired minimum size detected in designated surveillance areas
- o Percentage of lost tracks
- o Accuracy of the position and track obtained
- o Reliability of the surveillance system
- o Timeliness of the data obtained
- o Ability to interpret and use the data obtained

Secondary criteria are:

- o Cost of the VTS system -- reduction of manpower by the use of technology
- o Expandability -- increased VTS responsibility, area, and/or support of other missions

Active surveillance sensors including radar, communications, and closed circuit television (CCTV) installations are used when detection and tracking of vessels is paramount to providing safety advice. These devices are considered fail safe in that it is known with certainty when they have failed. The performance characteristics of these sensors are known from operational VTS worldwide experience. In this design they are selected to assure that the necessary operational criteria identified for each sub-zone is realized.

Many dependent surveillance techniques are possible. These range from voice radio reporting of required VTS data to automatic position and identification recording devices that can be interrogated from shore known as Automatic Dependent Surveillance (ADS) devices. The position and/or movement reporting form of dependent surveillance is used extensively in existing VTS systems. The major regions of current use are those which do not require active

surveillance. To apply ADS technology to a specific sub-zone within a VTS zone the following additional criteria must be considered:

o The number and class of vessels interacting in the sub-zone and which of these interactions are important to the VTS mission. Obviously all vessel classes of interest must be appropriately equipped. This requires that all vessels of the classes selected which will ever pass through this sub-zone must be equipped with an ADS device. This requirement to detect so many different vessels argues against the use of ADS. In areas where only one class of vessel is of interest, ADS is more easily implemented.

o The interactions or transits to be monitored must not demand that the surveillance be fail safe, i.e. positively detecting failures. This type of surveillance is related to position reporting in that it may not always function or be used properly and the VTS has limited control over its operation.

o It must be determined that if active surveillance is not justified, the additional information obtained from ADS over position reporting is necessary.

o If the class or group of vessels to be monitored is a "controllable" group, ADS can be easily implemented and satisfactory operation more readily achieved. Controllable means a clearly defined subset of vessels, e.g. a specific barge company; vessels carrying a specific cargo, etc.

o The number of different vessels in each class of interest that passes through the sub-zone in question must be determined. This number must be known to accurately estimate the cost of selecting this option for this sub-zone.

o A specific ADS solution for one sub-zone in one harbor may affect all the VTS designs for all the other sub-zones in all the other harbors.

3.1.2 Assumptions

The design of a VTS system for the Philadelphia VTS zone starts with a set of assumptions based on the detailed survey and other data. These assumptions are as follows:

o As recommended by the IMO, all vessels of 20 meters or more in length are required to participate in the VTS. Participation is defined (at a minimum) as monitoring the VTS frequency and reporting as required.

- The VTS system is implemented with the cooperation and assistance of the port authorities, pilots associations, and marine exchange, if any. The existing facilities, services, and procedures established and operated by these organizations are major elements of an integrated VTS system as defined in the IMO VTS Guidelines.

- The life-cycle of all system hardware is ten years.

3.2 DESIGN DECISIONS (FIGURE 3-1)

3.2.1 General

Examination of the traffic levels, geographical features and identified problem areas in this port leads to the overall conclusion that one control sector managed by one watchstander is sufficient.

3.2.2 Hardware Location and Selection

3.2.2.1 Sub-Zone I

<u>Raccoon Island</u>	1 Module 10 VHF 1 Module 13 MET
<u>Wilmington Site</u>	1 Module 10 VHF

3.2.2.2 Sub-Zone II

<u>Hawk Island</u>	1 Module 10 VHF 1 Module 12 MET
<u>Bordentown Site</u>	1 Module 10 VHF

3.2.2.3 Sub-Zone III

<u>Philadelphia Site</u>	1 Module 10 VHF 1 Module 11 VHF 1 Module 15 HYD

3.2.3 Vessel Traffic Center

The design of the hardware and software should be modern and capable of operating with reduced staff levels and no loss of effectiveness. One watchstander with an integrated data workstation and decision aiding software can effectively manage the activity in this port. This Vessel Traffic Center concept demands that the watchstander be separated from any other harbor/port information requests. The Center must be structured so that such requests are controlled by a bulletin board type interface. One officer-in-charge and one clerk are also required for the proper administration of the facility.

Surve-illance Mod-ules-Sub Zones	RADAR						ADS			VHF		MET.		HYD.		DF	CCTV		COMMENTS
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
I										2			1						
II										2		1							
III										1	1				1				

FIGURE 3-1. PHILADELPHIA/DELAWARE BAY, PA SURVEILLANCE SURVEY

The Vessel Traffic Center is located in Philadelphia in a location with good visual surveillance of the port. The center is to employ the following equipment:

3.2.3.1 VTS Console

This console provides total data integration from all sensors in all sectors. These data are graphically shown on raster scan, high light level, color displays. A data display is also provided. Console design architecture is general purpose computer based, open architecture, bus organized, allowing operation of the system as a local area network (LAN). Data interchange with other facilities by modem is provided as well as interface with the U.S. Coast Guard standard terminal. The design allows board level modification and expansion. Features of the software and hardware provided are:

- Software written in a high level language.

- Software providing the total integration of data from all VTS sensors.

- Layering of data in at least four layers to be operator selectable.

- The ability to sector data including sector to sector handoff of targets.

- The ability to accept external digital data derived from transmissions of shipboard transponders or other sources and integrate the information with all other sensor data.

- Automatic and/or manual acquisition of radar targets including automatic tracking and target ID assignments. Guard zones with automatic acquisition of all targets entering the zone.

- Several warning levels of vessel interaction designed to direct attention to developing situations rather than a simple CPA alarm strategy.

- Complete vessel monitoring and alarm capability including anchor watch, CPA, TCPA, track history, adjustable target velocity vectors, restricted area penetration and maneuvering monitor is provided. Additional warning and/or alarm features allowed by programming changes in high level language.

- o Complete modern color graphics capability with offset and zoom

- o Complete harbor navigation aid monitoring capability including buoy position, light status, etc.

- o Remote control of all radars and radar interfaces as well as radar data processing including site-to-site integration, clutter suppression, scan conversion and target extraction.

- o Complete track projection capability which can predict and/or analyze future interactions based on current position, destination and velocity.

- o The capability of constructing a complete vessel data base and interfacing it to the real-time data display from the VTS sensors.

3.2.3.2 Communications Console

This console is capable of remotely operating the proposed transmitting/receiving sites and allowing transmission and monitoring on all required frequencies. The console provides two operating positions each to be capable of complete communications control. It is capable of modular expansion if other remote communications sites are added.

3.2.3.3 Supervisor Control and Data Acquisition (SCADA) Equipment

A SCADA capability is provided to the major module level at remote sites so that the watchstander can determine the status of the entire VTS system. A graphic readout is provided in block diagram form indicating operational status of all elements in the system. Security monitoring of remote sites is also included.

3.2.3.4 Recording Equipment

Time synchronized video and audio recording equipment is to be provided. This equipment is capable of recording and playing back the data presented to the VTS watchstander and his reaction to the situation. An extra set of recording equipment is to be installed for redundancy purposes.

3.3 COST ESTIMATES

3.3.1 General

Vol. III, Technical Supplement discusses a generalized approach to estimating VTS system costs. This approach is based on interviews with system designers and purchasers of recently constructed systems. The cost of the Philadelphia VTS system has been estimated using this approach and is detailed below. The assumptions made in estimating these costs are listed in Paragraph 3.1.2.

3.3.2 Hardware (x $1000)

Vessel Traffic Center	non-recurring	recurring(10-yr)
VTS Console (1 workstation & all software)	500	
Communications console	100	
Recording Equipment	50	
Sub-total:	650	300
Sub-Zone I--Lower Delaware River (NOAA Chart 12312)		
2 Module 10 VHF	38	26
1 Module 13 MET	40	5
Sub-total:	78	31
Sub-Zone II--Upper Delaware River (NOAA Chart 12314)		
2 Module 10 VHF	39	26
1 Module 12 MET	20	5
Sub-total:	59	31
Sub-Zone III--Philadelphia (NOAA Chart 12312, 12313 & 12314)		
1 Module 10 VHF	19	13
1 Module 11 VHF	48	20
1 Module 15 HYD	50	5
Sub-total:	117	38
HARDWARE TOTALS:	904	400

3.3.3 Project Totals(x $1000)

Non-recurring

Hardware	$ 904
Management, Engineering, etc. (50%) Assumptions: Turnkey system, Procurement by integ.contractor, good manufacturer support, some software provided, System Manual required	453
Installation site integration (10%) Assumptions: Complete installation by contractor, remote access no serious problem, many widespread sites	91
Spares & Training (10%)	91
Civil Engineering a VTC in Philadelphia, remote comms and WX sensors installations, minor land acquisition	750
PROJECT ESTIMATE:	2289
Data Base Management System	300
TOTAL: (non-recurring)	$ 2589

Recurring (10 year)

Hardware	400
1 Watchstander x 5 = 5 man/years @ 50K x 10	2500
1 Officer-in-Charge	500
1 Clerk	500
TOTAL: (recurring) (10-year life)	$ 3900
TOTAL 10-YEAR PROJECT COST:	$ 6489

REFERENCES

1. Summary Statistics on Leading U.S. Ports, 1987, Center for Marine Conservation, Washington, D.C. 1990.

2. Final Report, National Vessel Traffic Services Study (TP5965E), Canadian Coast Guard, Ottawa 1984, pp. 89-91.

GLOSSARY

ADS: Automatic Dependent Surveillance

ARPA: Automatic Radar Plotting Aid.

"CONFINED-COMPLEX": a combination of terms relating to the geography and the nature of the interactions between ships. See Final Report National Vessel Traffic Services Study (TP-5965E), Canadian Coast Guard, Ottawa, October 1984, pp.89-91.

"CONFINED-SIMPLE": a combination terms relating to the geography and the nature of the interactions between ships. See Final Report National Vessel Traffic Services Study (TP-5965E), Canadian Coast Guard, Ottawa, October 1984, pp.89-91.

COTP: Captain of the Port

CCTV: closed circuit television

COLREGS LINE: a demarcation line delineating those waters upon which international regulations for the prevention of collisions at sea apply.

CPA: closest point of approach

DBMS: data base management system

DF: direction finder

FAA: Federal Aviation Administration

GIS: Geographic Information System

ICW: Intracoastal Waterway

IMO: International Maritime Organization

KW: Kilowatt

LAN: local area network

LLOYD'S LIST: a listing of all merchant vessels of the world including their physical characteristics. Published by Lloyd's of London.

LNG: liquified natural gas

NOAA: National Oceanic and Atmospheric Administration

"OPEN-COMPLEX": a combination of terms relating to the geography and the nature of the interactions between ships. See Final Report National Vessel Traffic Services Study (TP-5965E), Canadian Coast Guard, Ottawa, October 1984, pp. 89-91.

"OPEN-SIMPLE": a combination of terms relating to the geography and the nature of the interactions between ships. See Final Report National Vessel Traffic Services Study (TP-5965E), Canadian Coast Guard, Ottawa, October 1984, pp. 89-91.

PAI: Problem Area Identifier

PRECAUTIONARY AREA: an area normally an intersection, entrance to, or exit from a traffic separation scheme where vessel interactions are unpredictable

SCADA: Supervisor Control and Data Acquisition

TCPA: time of closest point of approach

TRAFFIC SEPARATION SCHEME: routes incorporating traffic separation to increase the safety of navigation, particularly in converging areas of high traffic density.

VHF: very high frequency

VTC: vessel traffic center

VTS: vessel traffic services

APPENDIX

COST SAVINGS DERIVED USING EXISTING SURVEILLANCE EQUIPMENT

PHILADELPHIA/DELAWARE BAY

1.0 HARDWARE COSTS (x $1000)

1.1 Vessel Traffic Center	non-recurring	recurring(10yr)
VTS Console (3 workstations & all software)	1000	
Communications console	100	
Recording Equipment	50	
SCADA Equipment (4 radar sites)	200	
Sub-total:	1350	600

1.2 PHILADELPHIA

Sub-Zone I--Lower Delaware River (NOAA Chart 12312)		
1 Module 1 radar	310	310
2 Module 10 VHF	38	26
1 Module 13 MET	40	5
Sub-total:	380	341

Sub-Zone II--Upper Delaware River (NOAA Chart 12314)		
2 Module 10 VHF	39	26
1 Module 12 MET	20	5
Sub-total:	59	31

Sub-Zone III--Philadelphia (NOAA Chart 12312, 12313 & 12314)		
1 Module 10 VHF	19	13
1 Module 11 VHF	48	20
1 Module 15 HYD	50	5
Sub-total:	117	38
PHILADELPHIA HARDWARE TOTALS:	1906	1010

1.3 DELAWARE BAY

Sub-Zone 1 Approaches

Comms/radar coverage from Sub-zone III.

Sub-Zone II

3 Module 3 radars	1200	1200
2 Module 10 VHF	39	26
1 Module 11 VHF	48	20
1 Module 13 MET	40	15
Sub-total:	1327	1251

Sub-Zone III--Wilmington Area

Radar coverage from Sub-zone III.

1 Module 10 VHF	19	13
1 Module 11 VHF	48	20
Sub-total:	67	33
DELAWARE BAY HARDWARE TOTALS:	1394	1284
HARDWARE TOTALS:	3300	2294

Philadelphia (Continued)

2.0 PROJECT TOTALS (x $1000)

2.1 NON-RECURRING

Hardware	$3300
Management, Engineering, etc. (50%) Assumptions: Turnkey system, Procurement by integ.contractor, good manufacturer support, some software provided, System Manual required	1980
Installation site integration (10%) Assumptions: Complete installation by contractor, remote access no serious problem, many widespread sites	660
Spares & Training (10%)	330
Civil Engineering a VTC in Philadelphia, remote comms and WX sensors installations, land acquisition	2000
PROJECT ESTIMATE:	8270
Data Base Management System	300
TOTAL: (non-recurring)	$ 8570

2.2 RECURRING (10 YEAR)

Hardware	2294
2 Watchstanders x 5 = 5 man/years @ 50K x 10	5000
1 Officer-in-Charge	500
1 Clerk	500
TOTAL: (recurring) (10-year life)	$ 8294
TOTAL 10-YEAR PROJECT COST:	$16864

Surveillance Modules-Sub Zones		RADAR						ADS			VHF		MET.		HYD.		DF	CCTV		COMMENTS
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
DELAWARE BAY	I																			
	II			3				10			2	1		1						
	III										1	1								
PHILA	I	1									2			1						
	II										2		1							
	III										1	1				1				

PHILADELPHIA/DELAWARE BAY, PA SURVEILLANCE SURVEY

STUDY ZONE INPUT DATA AND OUTPUT STATISTICS

Appendix M Zone 13 Philadelphia/Delaware Bay, PA

TABLE 1 Assignment of COE Waterway Codes to Subzones 8/06/91

COE Waterway		Name
Subzone 1301A		
235	A	INDIAN RIVER INLET AND BAY, DEL.
237	A	INLAND WATERWAY BETWEEN REHOBOTH BAY AND DELAWARE BAY, DEL.
240	A	MISPILLION RIVER, DEL.
241	A	MURDERKILL RIVER, DEL.
246	A	SMYRNA RIVER, DEL.
259	A	BIG TIMBER CREEK, N. J.
261	A	MANTUA CREEK, N. J.
263	A	OLDMANS CREEK, N. J.
267	A	COHANSEY RIVER, N. J.
268	A	MAURICE RIVER, N. J.
551	A	DELAWARE RIVER AT CAMDEN, N. J.
552	A	PHILADELPHIA HARBOR, PA.
554	A	WILMINGTON HARBOR, DELAWARE
557	A	SCHUYLKILL RIVER, PA.
5000	A	NEW JERSEY INTRACOASTAL WATERWAY
5073	A	CAPE MAY CANAL, N. J.
Subzone 1302B		
237	A	INLAND WATERWAY BETWEEN REHOBOTH BAY AND DELAWARE BAY, DEL.
238	A	HARBOR OF REFUGE, DELAWARE BAY, DEL.
240	A	MISPILLION RIVER, DEL.
241	A	MURDERKILL RIVER, DEL.
246	A	SMYRNA RIVER, DEL.
259	A	BIG TIMBER CREEK, N. J.
261	A	MANTUA CREEK, N. J.
263	A	OLDMANS CREEK, N. J.
267	A	COHANSEY RIVER, N. J.
268	A	MAURICE RIVER, N. J.
551	A	DELAWARE RIVER AT CAMDEN, N. J.
552	A	PHILADELPHIA HARBOR, PA.
554	A	WILMINGTON HARBOR, DELAWARE
557	A	SCHUYLKILL RIVER, PA.
Subzone 1303C		
237	A	INLAND WATERWAY BETWEEN REHOBOTH BAY AND DELAWARE BAY, DEL.
237	B	INLAND WATERWAY BETWEEN REHOBOTH BAY AND DELAWARE BAY, DEL.
238	A	HARBOR OF REFUGE, DELAWARE BAY, DEL.
240	A	MISPILLION RIVER, DEL.
240	B	MISPILLION RIVER, DEL.
241	A	MURDERKILL RIVER, DEL.
241	B	MURDERKILL RIVER, DEL.
246	A	SMYRNA RIVER, DEL.
259	A	BIG TIMBER CREEK, N. J.
259	B	BIG TIMBER CREEK, N. J.
261	A	MANTUA CREEK, N. J.
261	B	MANTUA CREEK, N. J.
263	A	OLDMANS CREEK, N. J.
263	B	OLDMANS CREEK, N. J.
267	A	COHANSEY RIVER, N. J.
267	B	COHANSEY RIVER, N. J.
268	A	MAURICE RIVER, N. J.
268	B	MAURICE RIVER, N. J.
551	A	DELAWARE RIVER AT CAMDEN, N. J.
551	B	DELAWARE RIVER AT CAMDEN, N. J.
552	A	PHILADELPHIA HARBOR, PA.

TABLE 1 Assignment of COE Waterway Codes to Subzones 8/06/91

COE Waterway		Name
Subzone 1303C		
552	B	PHILADELPHIA HARBOR, PA.
554	A	WILMINGTON HARBOR, DELAWARE
554	B	WILMINGTON HARBOR, DELAWARE
557	A	SCHUYLKILL RIVER, PA.
557	B	SCHUYLKILL RIVER, PA.
5000	A	NEW JERSEY INTRACOASTAL WATERWAY
5073	A	CAPE MAY CANAL, N. J.
Subzone 1304F		
248	A	INLAND WATERWAY FROM DELAWARE RIVER TO CHESAPEAKE BAY, DEL.
259	A	BIG TIMBER CREEK, N. J.
259	B	BIG TIMBER CREEK, N. J.
261	A	MANTUA CREEK, N. J.
261	B	MANTUA CREEK, N. J.
263	A	OLDMANS CREEK, N. J.
263	B	OLDMANS CREEK, N. J.
551	A	DELAWARE RIVER AT CAMDEN, N. J.
551	B	DELAWARE RIVER AT CAMDEN, N. J.
552	A	PHILADELPHIA HARBOR, PA.
552	B	PHILADELPHIA HARBOR, PA.
554	A	WILMINGTON HARBOR, DELAWARE
554	B	WILMINGTON HARBOR, DELAWARE
557	A	SCHUYLKILL RIVER, PA.
557	B	SCHUYLKILL RIVER, PA.

TABLE 2 Base Year 1987 Cargo Tons by Subzone, Commodity, and Vessel Type

Subzone 1301A

Comm. Code	Name	Dry Cargo	Tanker	Dry Cargo Barge Tow	Tanker Barge Tow	Total
1	FARM PRODUCTS	626,705	0	0	0	626,705
2	FOREST PRODUCTS	8,591	0	0	0	8,591
3	FISHERIES PRODUCTS	15,008	0	0	0	15,008
4	MINING PRODUCTS, NEC	5,177,957	0	351,352	0	5,529,309
5	PROC. FOODS & MFTRS, NEC	6,584,890	0	2,121,456	0	8,706,346
6	WASTE OF MANUFACTURING	924,105	0	36,647	0	960,752
1311	CRUDE PETROLEUM	0	13,986,945	0	5,579,742	19,566,687
1492	SULPHUR, DRY	1,427	0	0	0	1,427
2810	SODIUM HYDROXIDE (CAUSTI	9,513	0	0	0	9,513
2811	CRUDE PROD-COAL TAR-PET	32,592	0	0	0	32,592
2813	ALCOHOLS	0	8,910	0	13,160	22,070
2817	BENZENE AND TOLUENE	0	90,540	0	132,883	223,423
2818	SULPHURIC ACID	0	0	0	1,300	1,300
2871	NITROGEN CHEM FERTILIZER	20,879	58,079	0	13,015	91,973
2872	POTASSIC CHEM FERTILIZER	1	0	0	0	1
2873	PHOSPHA CHEM FERTILIZERS	2,064	0	7,381	0	9,445
2911	GASOLINE, INCL NATURAL	0	1,837,660	0	2,257,374	4,095,034
2912	JET FUEL	0	72,455	0	187,303	259,758
2913	KEROSENE	0	46,838	0	104,540	151,378
2914	DISTILLATE FUEL OIL	0	537,314	0	2,637,262	3,174,576
2915	RESIDUAL FUEL OIL	0	1,866,374	0	7,632,576	9,498,950
2916	LUBRIC OILS-GREASES	0	101,232	0	80,552	181,784
2917	NAPHTHA, PETRLM SOLVENTS	0	315,437	0	339,802	655,239
2921	LIQUI PETR-COAL-NATR GAS	0	121,120	0	44,725	165,845
	Subzone Total :	13,403,732	19,042,904	2,516,836	19,024,234	53,987,706

Subzone 1302B

Comm. Code	Name	Dry Cargo	Tanker	Dry Cargo Barge Tow	Tanker Barge Tow	Total
1	FARM PRODUCTS	626,705	0	0	0	626,705
2	FOREST PRODUCTS	8,591	0	0	0	8,591
3	FISHERIES PRODUCTS	15,008	0	0	0	15,008
4	MINING PRODUCTS, NEC	5,177,957	0	351,352	0	5,529,309
5	PROC. FOODS & MFTRS, NEC	6,582,890	0	2,121,456	0	8,704,346
6	WASTE OF MANUFACTURING	924,105	0	36,647	0	960,752
1311	CRUDE PETROLEUM	0	13,986,945	0	5,579,742	19,566,687
1492	SULPHUR, DRY	1,427	0	0	0	1,427
2810	SODIUM HYDROXIDE (CAUSTI	9,513	0	0	0	9,513
2811	CRUDE PROD-COAL TAR-PET	32,592	0	0	0	32,592
2813	ALCOHOLS	0	8,910	0	13,160	22,070
2817	BENZENE AND TOLUENE	0	90,540	0	132,883	223,423
2818	SULPHURIC ACID	0	0	0	1,300	1,300
2871	NITROGEN CHEM FERTILIZER	20,879	58,079	0	19,268	98,226
2872	POTASSIC CHEM FERTILIZER	1	0	0	0	1
2873	PHOSPHA CHEM FERTILIZERS	2,064	0	7,381	0	9,445
2911	GASOLINE, INCL NATURAL	0	1,837,660	0	2,257,374	4,095,034
2912	JET FUEL	0	72,455	0	187,303	259,758
2913	KEROSENE	0	46,838	0	104,540	151,378
2914	DISTILLATE FUEL OIL	0	537,314	0	2,629,518	3,166,832
2915	RESIDUAL FUEL OIL	0	1,866,374	0	7,632,576	9,498,950
2916	LUBRIC OILS-GREASES	0	101,232	0	80,552	181,784
2917	NAPHTHA, PETRLM SOLVENTS	0	315,437	0	339,802	655,239
2921	LIQUI PETR-COAL-NATR GAS	0	121,120	0	44,725	165,845
	Subzone Total :	13,401,732	19,042,904	2,516,836	19,022,743	53,984,215

TABLE 2 Base Year 1987 Cargo Tons by Subzone, Commodity, and Vessel Type

Subzone 1303C

Comm. Code	Name	Dry Cargo	Tanker	Dry Cargo Barge Tow	Tanker Barge Tow	Total
1	FARM PRODUCTS	626,705	0	0	0	626,705
2	FOREST PRODUCTS	8,591	0	0	0	8,591
3	FISHERIES PRODUCTS	15,008	0	0	0	15,008
4	MINING PRODUCTS, NEC	5,177,957	0	351,352	0	5,529,309
5	PROC. FOODS & MFTRS, NEC	6,584,890	0	2,121,456	0	8,706,346
6	WASTE OF MANUFACTURING	924,105	0	36,647	0	960,752
1311	CRUDE PETROLEUM	0	13,986,945	0	5,579,742	19,566,687
1492	SULPHUR, DRY	1,427	0	0	0	1,427
2810	SODIUM HYDROXIDE (CAUSTI	9,513	0	0	0	9,513
2811	CRUDE PROD-COAL TAR-PET	32,592	0	0	0	32,592
2813	ALCOHOLS	0	8,910	0	13,160	22,070
2817	BENZENE AND TOLUENE	0	90,540	0	132,883	223,423
2818	SULPHURIC ACID	0	0	0	1,300	1,300
2871	NITROGEN CHEM FERTILIZER	20,879	58,079	0	19,268	98,226
2872	POTASSIC CHEM FERTILIZER	1	0	0	0	1
2873	PHOSPHA CHEM FERTILIZERS	2,064	0	7,381	0	9,445
2911	GASOLINE, INCL NATURAL	0	1,837,660	0	2,257,374	4,095,034
2912	JET FUEL	0	72,455	0	187,303	259,758
2913	KEROSENE	0	46,838	0	104,540	151,378
2914	DISTILLATE FUEL OIL	0	537,314	0	2,637,262	3,174,576
2915	RESIDUAL FUEL OIL	0	1,866,374	0	7,632,576	9,498,950
2916	LUBRIC OILS-GREASES	0	101,232	0	80,552	181,784
2917	NAPHTHA, PETRLM SOLVENTS	0	315,437	0	339,802	655,239
2921	LIQUI PETR-COAL-NATR GAS	0	121,120	0	44,725	165,845
	Subzone Total :	13,403,732	19,042,904	2,516,836	19,030,487	53,993,959

Subzone 1304F

Comm. Code	Name	Dry Cargo	Tanker	Dry Cargo Barge Tow	Tanker Barge Tow	Total
1	FARM PRODUCTS	626,705	0	0	0	626,705
2	FOREST PRODUCTS	8,591	0	0	0	8,591
3	FISHERIES PRODUCTS	15,008	0	0	0	15,008
4	MINING PRODUCTS, NEC	5,177,957	0	330,021	0	5,507,978
5	PROC. FOODS & MFTRS, NEC	6,582,890	0	2,121,456	0	8,704,346
6	WASTE OF MANUFACTURING	924,105	0	36,647	0	960,752
1311	CRUDE PETROLEUM	0	13,986,945	0	5,579,742	19,566,687
1492	SULPHUR, DRY	1,427	0	0	0	1,427
2810	SODIUM HYDROXIDE (CAUSTI	9,513	0	0	0	9,513
2811	CRUDE PROD-COAL TAR-PET	32,592	0	0	0	32,592
2813	ALCOHOLS	0	8,910	0	13,160	22,070
2817	BENZENE AND TOLUENE	0	90,540	0	132,883	223,423
2818	SULPHURIC ACID	0	0	0	1,300	1,300
2871	NITROGEN CHEM FERTILIZER	20,879	58,079	0	13,015	91,973
2872	POTASSIC CHEM FERTILIZER	1	0	0	0	1
2873	PHOSPHA CHEM FERTILIZERS	2,064	0	7,381	0	9,445
2911	GASOLINE, INCL NATURAL	0	1,837,660	0	2,257,374	4,095,034
2912	JET FUEL	0	72,455	0	187,303	259,758
2913	KEROSENE	0	46,838	0	104,540	151,378
2914	DISTILLATE FUEL OIL	0	537,314	0	2,618,678	3,155,992
2915	RESIDUAL FUEL OIL	0	1,866,374	0	7,632,576	9,498,950
2916	LUBRIC OILS-GREASES	0	101,232	0	80,552	181,784
2917	NAPHTHA, PETRLM SOLVENTS	0	315,437	0	339,802	655,239
2921	LIQUI PETR-COAL-NATR GAS	0	121,120	0	44,725	165,845
	Subzone Total :	13,401,732	19,042,904	2,495,505	19,005,650	53,945,791

Appendix M ZONE 13 Philadelphia/Delaware Bay, PA

TABLE 3 Base Year (1987)
Vessel Transits by Subzone, Vessel Type, and Size.

Vessel Type	Large	Medium	Small	Total
Subzone : 1301A				
Passenger	0	38	0	38
Dry Cargo	353	2,704	47,299	50,356
Tanker	221	384	308	913
Dry Cargo Barge Tow	2	0	554	556
Tanker Barge Tow	863	0	3,989	4,852
Tug/Tow Boat	0	0	4,853	4,853
Subzone Total:	1,439	3,126	57,003	61,568
Subzone : 1302B				
Passenger	0	38	0	38
Dry Cargo	353	2,704	7,431	10,488
Tanker	221	384	308	913
Dry Cargo Barge Tow	2	0	554	556
Tanker Barge Tow	863	0	3,986	4,849
Tug/Tow Boat	0	0	4,847	4,847
Subzone Total:	1,439	3,126	17,126	21,691
Subzone : 1303C				
Passenger	0	38	6,000	6,038
Dry Cargo	353	2,704	59,045	62,102
Tanker	221	384	308	913
Dry Cargo Barge Tow	2	0	1,108	1,110
Tanker Barge Tow	863	0	7,975	8,838
Tug/Tow Boat	0	0	9,700	9,700
Subzone Total:	1,439	3,126	84,136	88,701
Subzone : 1304F				
Passenger	0	38	6,863	6,901
Dry Cargo	353	2,704	1,429	4,486
Tanker	221	384	308	913
Dry Cargo Barge Tow	2	0	1,074	1,076
Tanker Barge Tow	863	0	7,957	8,820
Tug/Tow Boat	0	0	9,631	9,631
Subzone Total:	1,439	3,126	27,262	31,827

Note: Sum of all vessel transits within each study subzone.

Appendix M ZONE 13 Philadelphia/Delaware Bay, PA

TABLE 3 Base Year (1987)
Vessel Transits by Suzone, Vessel Type, Size.

ZONE TOTALS

ZONE 13 Philadelphia/Delaware Bay, PA

Vessel Type	Large	Medium	Small	Total
Passenger	0	38	12,863	12,901
Dry Cargo	353	2,704	59,349	62,406
Tanker	221	384	308	913
Dry Cargo Barge Tow	2	0	1,108	1,110
Tanker Barge Tow	863	0	7,975	8,838
Tug/Tow Boat	0	0	9,7C0	9,700
Zone Total:	1,439	3,126	91,303	95,868

Note: Sum of all arrivals/departures to/from all terminals within the Study Zone.

Appendix M Zone 13 Philadelphia/Delaware Bay, PA

TABLE 4 Barges Per Tow - Average Factors by COE Waterway 8/6/91

COE Code	Waterway Name	Dry Barge	Tank Barge
SUBZONE	All Subzones within this Zone	1	1

NOTE: Average size of tows arriving/departing terminals within the waterway. Sizes of other tows transiting the area may differ.

Appendix M Zone 13 Philadelphia/Delaware Bay, PA

TABLE 5 Other Local Vessels by Subzone 7/21/91

Subzone	Name	Number of Vessels	Vessels per Square Mile
1301A		7,070	3.06
1302B		7,070	22.81
1303C		59,299	85.32
1304F		32,708	327.08
1305E		2,897	998.97
	Total for Zone	109,044	31.91

Note: State registered (1989/90) vessels estimated to be operated within the Subzone.

TABLE 6.1 Forecast 1995
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 1301A				
Passenger	0	39	0	39
Dry Cargo	462	3,495	59,217	63,174
Tanker	292	453	390	1,135
Dry Cargo Tow	0	0	1,287	1,287
Tanker Tow	1,003	0	8,837	9,840
Tug/Tow Boat	0	0	12,353	12,353
Subzone Total:	1,757	3,987	82,084	87,828
Subzone : 1302B				
Passenger	0	39	0	39
Dry Cargo	462	3,495	14,972	18,929
Tanker	292	453	390	1,135
Dry Cargo Tow	0	0	1,287	1,287
Tanker Tow	1,003	0	8,834	9,837
Tug/Tow Boat	0	0	12,345	12,345
Subzone Total:	1,757	3,987	37,828	43,572
Subzone : 1303C				
Passenger	0	39	6,204	6,243
Dry Cargo	462	3,495	64,537	68,494
Tanker	292	453	390	1,135
Dry Cargo Tow	0	0	1,287	1,287
Tanker Tow	1,003	0	8,840	9,843
Tug/Tow Boat	0	0	12,357	12,357
Subzone Total:	1,757	3,987	93,615	99,359
Subzone : 1304F				
Passenger	0	39	7,096	7,135
Dry Cargo	645	4,948	2,642	8,235
Tanker	295	575	460	1,330
Dry Cargo Tow	0	0	3,236	3,236
Tanker Tow	1,003	0	11,127	12,130
Tug/Tow Boat	0	0	12,557	12,557
Subzone Total:	1,943	5,562	37,118	44,623

Note: Sum of all vessel transits within each study subzone.

7/24/91

Appendix M ZONE 13 Philadelphia/Delaware Bay, PA

TABLE 6.2 Forecast 2000
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 1301A				
Passenger	0	41	0	41
Dry Cargo	555	4,137	62,825	67,517
Tanker	352	502	450	1,304
Dry Cargo Tow	0	0	1,412	1,412
Tanker Tow	1,135	0	9,449	10,584
Tug/Tow Boat	0	0	14,444	14,444
Subzone Total:	2,042	4,680	88,580	95,302
Subzone : 1302B				
Passenger	0	41	0	41
Dry Cargo	555	4,137	15,561	20,253
Tanker	352	502	450	1,304
Dry Cargo Tow	0	0	1,412	1,412
Tanker Tow	1,135	0	9,446	10,581
Tug/Tow Boat	0	0	14,434	14,434
Subzone Total:	2,042	4,680	41,303	48,025
Subzone : 1303C				
Passenger	0	41	6,414	6,455
Dry Cargo	555	4,137	68,265	72,957
Tanker	352	502	450	1,304
Dry Cargo Tow	0	0	1,412	1,412
Tanker Tow	1,135	0	9,452	10,587
Tug/Tow Boat	0	0	14,448	14,448
Subzone Total:	2,042	4,680	100,441	107,163
Subzone : 1304F				
Passenger	0	41	7,337	7,378
Dry Cargo	773	5,865	3,115	9,753
Tanker	356	633	525	1,514
Dry Cargo Tow	0	0	3,556	3,556
Tanker Tow	1,135	0	11,910	13,045
Tug/Tow Boat	0	0	14,691	14,691
Subzone Total:	2,264	6,539	41,134	49,937

Note: Sum of all vessel transits within each study subzone.

Appendix M ZONE 13 Philadelphia/Delaware Bay, PA

TABLE 6.3 Forecast 2005
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 1301A				
Passenger	0	42	0	42
Dry Cargo	676	4,950	66,766	72,392
Tanker	424	560	527	1,511
Dry Cargo Tow	0	0	1,553	1,553
Tanker Tow	1,291	0	10,128	11,419
Tug/Tow Boat	0	0	17,058	17,058
Subzone Total:	2,391	5,552	96,032	103,975
Subzone : 1302B				
Passenger	0	42	0	42
Dry Cargo	676	4,950	16,203	21,829
Tanker	424	560	527	1,511
Dry Cargo Tow	0	0	1,553	1,553
Tanker Tow	1,291	0	10,124	11,415
Tug/Tow Boat	0	0	17,049	17,049
Subzone Total:	2,391	5,552	45,456	53,399
Subzone : 1303C				
Passenger	0	42	6,603	6,644
Dry Cargo	676	4,950	72,321	77,947
Tanker	424	560	527	1,511
Dry Cargo Tow	0	0	1,553	1,553
Tanker Tow	1,291	0	10,132	11,423
Tug/Tow Boat	0	0	17,063	17,063
Subzone Total:	2,391	5,552	108,199	116,141
Subzone : 1304F				
Passenger	0	42	7,552	7,594
Dry Cargo	936	7,019	3,697	11,652
Tanker	428	701	607	1,736
Dry Cargo Tow	0	0	3,911	3,911
Tanker Tow	1,291	0	12,770	14,061
Tug/Tow Boat	0	0	17,365	17,365
Subzone Total:	2,655	7,762	45,902	56,319

Note: Sum of all vessel transits within each study subzone.

TABLE 6.4 Forecast 2010
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 1301A				
Passenger	0	43	0	43
Dry Cargo	836	5,989	71,124	77,949
Tanker	514	628	618	1,760
Dry Cargo Tow	0	0	1,707	1,707
Tanker Tow	1,478	0	10,875	12,353
Tug/Tow Boat	0	0	20,361	20,361
Subzone Total:	2,828	6,660	104,685	114,173
Subzone : 1302B				
Passenger	0	43	0	43
Dry Cargo	836	5,989	16,930	23,755
Tanker	514	628	618	1,760
Dry Cargo Tow	0	0	1,707	1,707
Tanker Tow	1,478	0	10,871	12,349
Tug/Tow Boat	0	0	20,352	20,352
Subzone Total:	2,828	6,660	50,478	59,966
Subzone : 1303C				
Passenger	0	43	6,796	6,839
Dry Cargo	836	5,989	76,798	83,623
Tanker	514	628	618	1,760
Dry Cargo Tow	0	0	1,707	1,707
Tanker Tow	1,478	0	10,879	12,357
Tug/Tow Boat	0	0	20,366	20,366
Subzone Total:	2,828	6,660	117,164	126,652
Subzone : 1304F				
Passenger	0	43	7,774	7,817
Dry Cargo	1,149	8,480	4,412	14,041
Tanker	519	780	703	2,002
Dry Cargo Tow	0	0	4,302	4,302
Tanker Tow	1,478	0	13,714	15,192
Tug/Tow Boat	0	0	20,742	20,742
Subzone Total:	3,146	9,303	51,647	64,096

Note: Sum of all vessel transits within each study subzone.

Appendix M ZONE 13 Philadelphia/Delaware Bay, PA

TABLE 6.5 Forecast 1995 - 2010 Vessel Transits by Vessel Type and Size

Vessel Type	Large	Medium	Small	Total
1995 FORECASTED ZONE TOTALS				
Passenger	0	39	13,300	13,339
Dry Cargo	414	3,150	64,677	68,241
Tanker	292	453	390	1,135
Dry Cargo Tow	0	0	1,287	1,287
Tanker Tow	1,003	0	8,840	9,843
Tug/Tow Boat	0	0	12,357	12,357
1995 Zone Total:	1,709	3,642	100,851	106,202
2000 FORECASTED ZONE TOTALS				
Passenger	0	41	13,751	13,792
Dry Cargo	465	3,494	68,265	72,224
Tanker	352	502	450	1,304
Dry Cargo Tow	0	0	1,412	1,412
Tanker Tow	1,135	0	9,452	10,587
Tug/Tow Boat	0	0	14,448	14,448
2000 Zone Total:	1,952	4,037	107,778	113,767
2005 FORECASTED ZONE TOTALS				
Passenger	0	42	14,155	14,197
Dry Cargo	567	4,038	72,205	76,810
Tanker	424	560	527	1,511
Dry Cargo Tow	0	0	1,553	1,553
Tanker Tow	1,291	0	10,132	11,423
Tug/Tow Boat	0	0	17,063	17,063
2005 Zone Total:	2,282	4,640	115,635	122,557
2010 FORECASTED ZONE TOTALS				
Passenger	0	43	14,570	14,613
Dry Cargo	702	4,883	76,610	82,195
Tanker	514	628	618	1,760
Dry Cargo Tow	0	0	1,707	1,707
Tanker Tow	1,478	0	10,879	12,357
Tug/Tow Boat	0	0	20,366	20,366
2010 Zone Total:	2,694	5,554	124,750	132,998

Note: Sum of all arrivals/departures to/from all terminals within the study zone.

Appendix M Zone 13 Philadelphia/Delaware Bay, PA 7/25/91

TABLE 7 Vessel Casualty History (10 Year Totals) by Subzone, Vessel Type and Size, and Casualty Type

Vessel Type	Size	Collisions	Rammings	Groundings	Other	Total
Subzone: 1301A						
Dry Cargo	Large	1	0	0	0	1
Tanker Barge Tow	Small	1	0	0	0	1
Subzone Totals:		2	0	0	0	2
Subzone: 1303C						
Dry Cargo	Small	0	0	1	0	1
Tanker	Large	0	0	3	0	3
Dry Cargo Barge Tow	Small	0	0	1	0	1
Tanker Barge Tow	Small	0	0	1	0	1
Subzone Totals:		0	0	6	0	6
Subzone: 1304F						
Passenger	Small	0	0	0	1	1
Dry Cargo	Large	0	0	4	0	4
Tanker	Large	0	1	3	0	4
Dry Cargo Barge Tow	Small	1	1	1	0	3
Tanker Barge Tow	Large	1	0	0	0	1
Tanker Barge Tow	Small	0	1	6	0	7
Tug/Tow Boat	Small	0	0	2	0	2
Subzone Totals:		2	3	16	1	22
Subzone: 1305E						
Dry Cargo	Large	1	0	0	0	1
Tanker Barge Tow	Small	1	0	0	0	1
Subzone Totals:		2	0	0	0	2
Zone Totals:		6	3	22	1	32

Note: OTHER equals barge breakaways and weather caused vessel casualties.

APPENDIX TABLE M-8 ZONE 13, PHILADELPHIA/DELAWARE BAY, PA - VTS LEVELS IN OPERATION

19	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95-2010
SUBZONE																	
1301A																	III
1302B	II	II	II	II	II	II	II	II	II	II	II	II					III
1303C	I	I	I	I	I	I	I	I	I	I	I	I					III
1304F	I	I	I	I	I	I	I	I	I	I	I	I					I
1305E	I	I	I	I	I	I	I	I	I	I	I	I					III

LEGEND

VTS Level I -
A Vessel Movement Reporting System consisting of VHF radio communications and various vessel reporting waypoints. No radar surveillance is included.

VTS Level II -
The Vessel Movement Reporting System of Level I is coupled with basic radar surveillance. The radar technology is assumed to be equivalent to a good quality, recent vintage, standard shipboard radar without any advanced features.

VTS Level III -
This level represents the new Coast Guard state-of-the-art Candidate VTS Design defined for each study zone.

NOTE ALL COMMERCIAL VESSELS PARTICIPATE 1979 TO PRESENT

APPENDIX TABLE M-9 ZONE 13 PHILADELPHIA/DELAWARE BAY, PA
CANDIDATE VTS DESIGN - 1995-2010

UNITS

1	Radar Module 1	- Average Performance
0	Radar Module 2	- Average Performance
3	Radar Module 3	- High Performance
0	Radar Module 4	- High Performance
0	Radar Module 5	- Special Purpose
0	Radar Module 6	- Special Purpose
10	ADS Module 7	- Active Radar Transponder (Type 1)
0	ADS Module 8	- Positional Transponder, Small Area, Very High Accuracy (Type 5)
0	ADS Module 9	- Positional Transponder, Small Area, High Accuracy (Type 6)
8	VHF Module 10	- Low power VHF Transmitting/ Receiving Facility
3	VHF Module 11	- High power VHF Transmitting/ Receiving Facility
1	Meteorological Module 12	- Air temperature, wind direction and speed
2	Meteorological Module 13	- Air temperature, wind direction and speed, visibility
0	Hydrological Module 14	- Water Temperature and Depth
1	Hydrological Module 15	- Water Temperature, Depth and Current
0	VHF/DF MODULE 16	- Line of position measurement to 2 degree RMS
0	CCTV MODULE 17	- Fixed Focus CCTV via Telephone Lines
0	CCTV MODULE 18	- Remotely Controllable CCTV via

TABLE 10A — Avoided Vessel Casualties 1996 - 2010 — 7/31/91

Candidate VTS Systems

Counts

Vessel Type	Size	Collision	Ramming	Grounding	Total
Passenger	Medium	.07	0.00	.09	.16
Passenger	Small	.15	.03	.18	.37
Dry Cargo	Large	.39	.09	.63	1.11
Dry Cargo	Medium	1.14	.24	.59	1.96
Dry Cargo	Small	4.03	.54	1.06	5.63
Tanker	Large	.58	.17	1.04	1.79
Tanker	Medium	.10	.01	.08	.19
Tanker	Small	.04	0.00	.04	.07
Dry Cargo Barge T	Small	.58	.24	.30	1.11
Tanker Barge Tow	Large	.53	.32	.45	1.30
Tanker Barge Tow	Small	4.14	.98	3.54	8.66
Tug/Tow Boat	Small	.65	.27	.69	1.60
		12.39	2.88	8.68	23.95

Undiscounted Total Dollar Losses (1,000)

Vessel Type	Size	Collision	Ramming	Grounding	Total
Passenger	Medium	115	0	103	218
Passenger	Small	134	29	111	273
Dry Cargo	Large	542	158	198	899
Dry Cargo	Medium	1,703	461	176	2,340
Dry Cargo	Small	2,748	389	646	3,783
Tanker	Large	3,365	1,063	3,599	8,027
Tanker	Medium	148	21	40	209
Tanker	Small	24	0	10	34
Dry Cargo Barge T	Small	32	36	5	73
Tanker Barge Tow	Large	2,961	1,846	1,695	6,502
Tanker Barge Tow	Small	11,457	2,816	1,705	15,978
Tug/Tow Boat	Small	49	44	48	141
		23,279	6,863	8,335	38,477

Note: In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 10B

Avoided Vessel Casualties 1996 - 2010
Existing VTS Systems

7/31/91

Counts

Vessel Type	Size	Collision	Ramming	Grounding	Total
Passenger	Medium	.03	0.00	.03	.06
Passenger	Small	.07	.02	.06	.15
Dry Cargo	Large	.16	.05	.23	.44
Dry Cargo	Medium	.46	.15	.21	.82
Dry Cargo	Small	.46	.21	.16	.84
Tanker	Large	.24	.11	.37	.72
Tanker	Medium	.04	.01	.03	.07
Tanker	Small	.01	0.00	.01	.03
Dry Cargo Barge T	Small	.23	.16	.10	.48
Tanker Barge Tow	Large	.21	.20	.16	.58
Tanker Barge Tow	Small	1.63	.65	1.15	3.43
Tug/Tow Boat	Small	.15	.14	.17	.47
		3.69	1.70	2.69	8.07

Undiscounted Total Dollar Losses (1,000)

Vessel Type	Size	Collision	Ramming	Grounding	Total
Passenger	Medium	46	0	35	81
Passenger	Small	59	21	37	118
Dry Cargo	Large	222	98	71	391
Dry Cargo	Medium	696	286	63	1,045
Dry Cargo	Small	316	150	100	566
Tanker	Large	1,403	669	1,305	3,376
Tanker	Medium	63	14	15	91
Tanker	Small	9	0	3	12
Dry Cargo Barge T	Small	13	23	2	37
Tanker Barge Tow	Large	1,226	1,152	611	2,988
Tanker Barge Tow	Small	4,581	1,882	562	7,025
Tug/Tow Boat	Small	11	22	12	45
		8,643	4,317	2,816	15,776

Note: In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 11 Avoided Fatalities 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Medium	.01	0.00	.01	.02
Passenger	Small	.01	.00	.01	.02
Dry Cargo	Large	.05	.01	.08	.14
Dry Cargo	Medium	.14	.03	.07	.25
Dry Cargo	Small	.26	.03	.07	.36
Tanker	Small	.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	.00	.00	.00	.00
Tanker Barge Tow	Small	.01	.00	.01	.02
Tug/Tow Boat	Small	.00	.00	.00	.00
Totals		.48	.08	.25	.81
Candidate VTS Design - Dollars					
Passenger	Medium	12,262.03	0.00	17,441.01	29,703.04
Passenger	Small	14,815.07	3,167.69	17,220.77	35,203.54
Dry Cargo	Large	73,576.66	16,190.19	118,407.89	208,174.74
Dry Cargo	Medium	213,572.10	44,515.00	110,454.69	368,541.79
Dry Cargo	Small	387,476.10	51,377.26	102,053.41	540,906.77
Tanker	Small	120.04	0.00	123.58	243.62
Dry Cargo Barge Tow	Small	1,914.42	784.34	978.45	3,677.20
Tanker Barge Tow	Small	13,685.89	3,245.08	11,707.92	28,638.89
Tug/Tow Boat	Small	2,142.43	881.34	2,279.84	5,303.62
Totals		719,564.73	120,160.91	380,667.56	1,220,393.21
Existing VTS Design - Counts					
Passenger	Medium	.00	0.00	.00	.01
Passenger	Small	.00	.00	.00	.01
Dry Cargo	Large	.02	.01	.03	.05
Dry Cargo	Medium	.06	.02	.03	.10
Dry Cargo	Small	.03	.01	.01	.05
Tanker	Small	.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	.00	.00	.00	.00
Tanker Barge Tow	Small	.00	.00	.00	.01
Tug/Tow Boat	Small	.00	.00	.00	.00
Totals		.12	.04	.08	.24
Existing VTS Design - Dollars					
Passenger	Medium	4,986.65	0.00	6,250.02	11,236.67
Passenger	Small	6,560.28	2,352.81	5,744.11	14,657.20
Dry Cargo	Large	29,921.72	10,108.62	42,431.73	82,462.08
Dry Cargo	Medium	86,854.24	27,793.69	39,581.69	154,229.62
Dry Cargo	Small	44,546.84	19,894.40	15,843.98	80,285.21
Tanker	Small	45.43	0.00	40.67	86.11
Dry Cargo Barge Tow	Small	744.51	519.52	315.58	1,579.60
Tanker Barge Tow	Small	5,379.25	2,159.87	3,801.02	11,340.15
Tug/Tow Boat	Small	499.20	464.36	574.40	1,537.96
Totals		179,538.12	63,293.28	114,583.21	357,414.61

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 12 Avoided Human Injuries 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Medium	.00	0.00	.00	.00
Passenger	Small	.12	.03	.14	.28
Dry Cargo	Large	.01	.00	.01	.02
Dry Cargo	Medium	.02	.00	.01	.03
Dry Cargo	Small	3.06	.41	.81	4.28
Tanker	Small	.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	.01	.01	.01	.03
Tanker Barge Tow	Small	.10	.02	.09	.21
Tug/Tow Boat	Small	.02	.01	.02	.04
Totals		3.33	.47	1.07	4.88
Candidate VTS Design - Dollars					
Passenger	Medium	210.54	0.00	299.46	509.99
Passenger	Small	27,897.03	5,964.82	32,427.00	66,288.85
Dry Cargo	Large	1,263.29	277.98	2,033.03	3,574.31
Dry Cargo	Medium	3,666.98	764.31	1,896.48	6,327.77
Dry Cargo	Small	729,623.93	96,744.23	192,168.26	1,018,536.42
Tanker	Small	209.75	0.00	215.93	425.68
Dry Cargo Barge Tow	Small	3,345.08	1,370.49	1,709 65	6 425.22
Tanker Barge Tow	Small	23,913.55	5,670.18	20,457.42	50,041.14
Tug/Tow Boat	Small	3,743.50	1,539.99	3,983.60	9,267.09
Totals		793,873.64	112,331.99	255,190.84	1,161,396.47
Existing VTS Design - Counts					
Passenger	Medium	.00	0.00	.00	.00
Passenger	Small	.05	.02	.05	.12
Dry Cargo	Large	.00	.00	.00	.01
Dry Cargo	Medium	.01	.00	.00	.01
Dry Cargo	Small	.35	.16	.13	.63
Tanker	Small	.00	0.00	.00	00
Dry Cargo Barge Tow	Small	.01	.00	.00	.01
Tanker Barge Tow	Small	.04	.02	.07	.08
Tug/Tow Boat	Small	.00	.00	.00	.01
Totals		.46	.20	.21	.88
Existing VTS Design - Dollars					
Passenger	Medium	85.62	0.00	107.31	192.93
Passenger	Small	12,353.12	4,430.39	10,816.25	27,599.76
Dry Cargo	Large	513.75	173.56	728.54	1,415.85
Dry Cargo	Medium	1,491.26	477.21	679.61	2,648.08
Dry Cargo	Small	83,882.43	37,461.48	29,834.47	151,178.39
Tanker	Small	79.39	0.00	71.07	150.46
Dry Cargo Barge Tow	Small	1,300.89	907.77	551.41	2,760.06
Tanker Barge Tow	Small	9,399.25	3,773.97	6,641.58	19,814.81
Tug/Tow Boat	Small	872.25	811.39	1,003.66	2,687.30
Totals		109,977.95	48,035.77	50,433.91	208,447.64

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 13   Avoided Vessels Damaged 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Medium	.05	0.00	.04	.09
Passenger	Small	.13	.02	.06	.21
Dry Cargo	Large	.29	.06	.06	.41
Dry Cargo	Medium	.84	.17	.06	1.07
Dry Cargo	Small	3.46	.37	.56	4.39
Tanker	Large	.44	.14	.14	.71
Tanker	Medium	.07	.01	.01	.09
Tanker	Small	.01	0.00	.01	.02
Dry Cargo Barge Tow	Small	.44	.10	.04	.58
Tanker Barge Tow	Large	.48	.16	.09	.73
Tanker Barge Tow	Small	3.16	.41	.49	4.07
Tug/Tow Boat	Small	.11	.03	.09	.23
Totals		9.48	1.48	1.63	12.60
Candidate VTS Design - Dollars					
Passenger	Medium	42,184.48	0.00	34,839.30	77,023.79
Passenger	Small	44,821.24	7,490.58	28,867.89	81,179.71
Dry Cargo	Large	213,854.83	45,034.10	36,463.63	295,352.56
Dry Cargo	Medium	749,942.81	149,589.26	25,430.87	924,962.95
Dry Cargo	Small	656,458.86	70,777.60	142,924.63	870,161.09
Tanker	Large	343,389.38	109,263.66	293,104.09	745,757.13
Tanker	Medium	48,512.54	6,258.67	18,187.98	72,959.19
Tanker	Small	2,378.95	0.00	3,194.56	5,573.51
Dry Cargo Barge Tow	Small	25,657.97	5,820.79	2,093.79	33,572.55
Tanker Barge Tow	Large	78,172.33	26,094.12	17,905.47	122,171.91
Tanker Barge Tow	Small	224,093.26	29,422.09	44,510.28	298,025.63
Tug/Tow Boat	Small	8,174.54	2,159.90	8,458.60	18,793.05
Totals		2,437,641.19	451,910.78	655,981.09	3,545,533.06
Existing VTS Design - Counts					
Passenger	Medium	.02	0.00	.01	.03
Passenger	Small	.06	.02	.02	.09
Dry Cargo	Large	.12	.04	.02	.18
Dry Cargo	Medium	.34	.10	.02	.47
Dry Cargo	Small	.40	.14	.09	.63
Tanker	Large	.18	.09	.05	.31
Tanker	Medium	.03	.01	.00	.04
Tanker	Small	.00	0.00	.00	.01
Dry Cargo Barge Tow	Small	.17	.07	.01	.25
Tanker Barge Tow	Large	.20	.10	.03	.33
Tanker Barge Tow	Small	1.24	.28	.16	1.68
Tug/Tow Boat	Small	.03	.02	.02	.06
Totals		2.78	.85	.44	4.08
Existing VTS Design - Dollars					
Passenger	Medium	17,155.34	0.00	12,484.74	29,640.08
Passenger	Small	19,847.34	5,563.65	9,629.09	35,040.08
Dry Cargo	Large	86,969.22	28,117.80	13,066.82	128,153.85
Dry Cargo	Medium	304,982.32	93,398.59	9,113.21	407,494.13
Dry Cargo	Small	75,470.89	27,406.64	22,189.31	125,066.83
Tanker	Large	139,647.57	68,220.62	105,034.50	312,902.69
Tanker	Medium	19,728.80	3,907.71	6,517.70	30,154.21
Tanker	Small	900.43	0.00	1,051.41	1,951.85
Dry Cargo Barge Tow	Small	9,978.25	3,855.50	675.31	14,509.06
Tanker Barge Tow	Large	31,790.66	16,292.31	6,416.46	54,499.43
Tanker Barge Tow	Small	88,080.11	19,582.85	14,450.45	122,113.41
Tug/Tow Boat	Small	1,904.71	1,138.01	2,131.12	5,173.84
Totals		796,455.64	267,483.67	202,760.13	1,266,699.44

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 14 Avoided Cargo Damage/Loss 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Medium	.01	0.00	.01	.02
Passenger	Small	.03	.01	.02	.05
Dry Cargo	Large	.10	.03	.06	.19
Dry Cargo	Medium	.30	.08	.05	.44
Dry Cargo	Small	1.28	.15	.21	1.65
Tanker	Large	.16	.05	.10	.31
Tanker	Medium	.03	.00	.01	.04
Tanker	Small	.01	0.00	.00	.01
Dry Cargo Tow	Small	.08	.03	.02	.13
Tanker Tow	Large	.04	.02	.03	.10
Tanker Tow	Small	.58	.14	.20	.92
Tug/Tow Boat	Small	.04	.01	.02	.08
Totals		2.67	.53	.74	3.95
Candidate VTS Design - Dollars					
Passenger	Medium	185.58	0.00	108.43	294.01
Passenger	Small	113.35	18.94	65.19	197.49
Dry Cargo	Large	1,101.04	343.25	167.56	1,611.85
Dry Cargo	Medium	3,196.00	943.78	156.30	296.08
Dry Cargo	Small	2,979.19	321.21	641.57	3,941.97
Tanker	Large	10,470.53	3,174.25	15,465.69	29,110.47
Tanker	Medium	366.17	46.60	94.40	507.18
Tanker	Small	28.99	0.00	18.83	47.82
Tanker Tow	Large	15,020.95	9,116.42	12,192.09	36,329.46
Tanker Tow	Small	35,198.31	8,346.39	12,263.86	55,808.56
Tug/Tow Boat	Small	98.40	26.00	99.11	223.51
Totals		68,758.51	22,336.84	41,273.05	132,368.40
Existing VTS Design - Counts					
Passenger	Medium	.01	0.00	.00	.01
Passenger	Small	.01	.00	.01	.02
Dry Cargo	Large	.04	.02	.02	.08
Dry Cargo	Medium	.12	.05	.02	.19
Dry Cargo	Small	.15	.06	.03	.24
Tanker	Large	.06	.03	.04	.13
Tanker	Medium	.01	.00	.00	.02
Tanker	Small	.00	0.00	.00	.00
Dry Cargo Tow	Small	.03	.02	.01	.06
Tanker Tow	Large	.02	.02	.01	.04
Tanker Tow	Small	.23	.09	.07	.39
Tug/Tow Boat	Small	.01	.01	.01	.02
Totals		.70	.30	.21	1.21
Existing VTS Design - Dollars					
Passenger	Medium	75.47	0.00	38.86	114.33
Passenger	Small	50.19	14.07	21.75	86.01
Dry Cargo	Large	447.76	214.32	60.05	722.13
Dry Cargo	Medium	1,299.73	589.26	56.01	1,945.01
Dry Cargo	Small	342.51	124.38	99.61	566.49
Tanker	Large	4,648.78	2,162.04	6,131.03	12,941.86
Tanker	Medium	153.03	29.87	36.58	219.47
Tanker	Small	12.26	0.00	6.67	18.92
Tanker Tow	Large	6,763.66	6,302.33	4,836.89	17,902.88
Tanker Tow	Small	21,181.81	8,504.31	6,094.02	35,780.14
Tug/Tow Boat	Small	22.93	13.70	24.97	61.60
Totals		34,998.13	17,954.28	17,406.42	70,358.83

Note1: Dollar values include bulk petroleum and chemical cargos only and all vessel fuels spilled. Dollar values exclude cargo loss/damage for non-tank vessel types.

Note2: In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 15 Avoided NavAid Damage 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Small	0.00	.00	.00	.00
Dry Cargo	Large	0.00	.01	.00	.01
Dry Cargo	Medium	0.00	.03	.00	.03
Dry Cargo	Small	0.00	.06	.01	.07
Tanker	Large	0.00	.02	.01	.03
Tanker	Medium	0.00	.00	.00	.00
Tanker	Small	0.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	0.00	.03	.00	.03
Tanker Barge Tow	Large	0.00	.04	.00	.04
Tanker Barge Tow	Small	0.00	.11	.02	.13
Tug/Tow Boat	Small	0.00	.03	.00	.03
Totals		0.00	.33	.05	.38
Candidate VTS Design - Dollars					
Passenger	Small	0.00	21.30	5.80	27.09
Dry Cargo	Large	0.00	55.56	20.34	75.90
Dry Cargo	Medium	0.00	152.76	18.98	171.74
Dry Cargo	Small	0.00	345.41	34.35	379.76
Tanker	Large	0.00	112.17	33.55	145.72
Tanker	Medium	0.00	7.63	2.50	10.13
Tanker	Small	0.00	0.00	1.21	1.21
Dry Cargo Barge Tow	Small	0.00	153.17	9.57	162.74
Tanker Barge Tow	Large	0.00	206.77	14.50	221.27
Tanker Barge Tow	Small	0.00	633.72	114.46	748.18
Tug/Tow Boat	Small	0.00	172.11	22.29	194.40
Totals		0.00	1,860.61	277.53	2,138.13
Existing VTS Design - Counts					
Passenger	Small	0.00	.00	.00	.00
Dry Cargo	Large	0.00	.01	.00	.01
Dry Cargo	Medium	0.00	.02	.00	.02
Dry Cargo	Small	0.00	.02	.00	.02
Tanker	Large	0.00	.01	.00	.01
Tanker	Medium	0.00	.00	.00	.00
Tanker	Small	0.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	0.00	.02	.00	.02
Tanker Barge Tow	Large	0.00	.02	.00	.02
Tanker Barge Tow	Small	0.00	.07	.01	.08
Tug/Tow Boat	Small	0.00	.02	.00	.02
Totals		0.00	.19	.02	.21
Existing VTS Design - Dollars					
Passenger	Small	0.00	15.82	1.93	17.75
Dry Cargo	Large	0.00	34.69	7.29	41.98
Dry Cargo	Medium	0.00	95.38	6.80	102.18
Dry Cargo	Small	0.00	133.75	5.33	139.08
Tanker	Large	0.00	70.04	12.02	82.06
Tanker	Medium	0.00	4.76	.89	5.66
Tanker	Small	0.00	0.00	.40	.40
Dry Cargo Barge Tow	Small	0.00	101.45	3.09	104.54
Tanker Barge Tow	Large	0.00	129.10	5.20	134.30
Tanker Barge Tow	Small	0.00	421.79	37.16	458.95
Tug/Tow Boat	Small	0.00	90.68	5.62	96.30
Totals		0.00	1,097.47	85.73	1,183.20

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 16 Avoided Bridge Damage 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Small	.00	.00	0.00	.00
Dry Cargo	Large	0.00	.01	0.00	.01
Dry Cargo	Medium	0.00	.02	0.00	.02
Dry Cargo	Small	.01	.03	0.00	.04
Tanker	Large	0.00	.02	0.00	.02
Tanker	Medium	0.00	.00	0.00	.00
Tanker	Small	.00	0.00	0.00	.00
Dry Cargo Barge Tow	Small	.00	.01	0.00	.01
Tanker Barge Tow	Large	0.00	.03	0.00	.03
Tanker Barge Tow	Small	.01	.06	0.00	.06
Tug/Tow Boat	Small	.00	.02	0.00	.02
Totals		.01	.21	0.00	.22
Candidate VTS Design - Dollars					
Passenger	Small	429.26	4,126.89	0.00	4,556.15
Dry Cargo	Large	0.00	17,785.31	0.00	17,785.31
Dry Cargo	Medium	0.00	48,900.77	0.00	48,900.77
Dry Cargo	Small	10,948.73	65,286.57	0.00	76,235.30
Tanker	Large	0.00	35,906.62	0.00	35,906.62
Tanker	Medium	0.00	2,442.68	0.00	2,442.68
Tanker	Small	87.35	0.00	0.00	87.35
Dry Cargo Barge Tow	Small	1,478.83	27,593.22	0.00	29,072.05
Tanker Barge Tow	Large	0.00	66,188.98	0.00	66,188.98
Tanker Barge Tow	Small	10,578.79	114,249.01	0.00	124,827.80
Tug/Tow Boat	Small	1,600.57	29,755.72	0.00	31,356.29
Totals		25,123.53	412,235.77	0.00	437,359.30
Existing VTS Design - Counts					
Passenger	Small	.00	.00	0.00	.00
Dry Cargo	Large	0.00	.01	0.00	.01
Dry Cargo	Medium	0.00	.01	0.00	.01
Dry Cargo	Small	.00	.01	0.00	.01
Tanker	Large	0.00	.01	0.00	.01
Tanker	Medium	0.00	.00	0.00	.00
Tanker	Small	.00	0.00	0.00	.00
Dry Cargo Barge Tow	Small	.00	.01	0.00	.01
Tanker Barge Tow	Large	0.00	.02	0.00	.02
Tanker Barge Tow	Small	.00	.04	0.00	.04
Tug/Tow Boat	Small	.00	.01	0.00	.01
Totals		.00	.12	0.00	.12
Existing VTS Design - Dollars					
Passenger	Small	190.08	3,065.26	0.00	3,255.34
Dry Cargo	Large	0.00	10,433.84	0.00	10,433.84
Dry Cargo	Medium	0.00	28,687.87	0.00	28,687.87
Dry Cargo	Small	1,077.16	24,336.43	0.00	25,413.58
Tanker	Large	0.00	21,064.79	0.00	21,064.79
Tanker	Medium	0.00	1,433.01	0.00	1,433.01
Tanker	Small	27.74	0.00	0.00	27.74
Dry Cargo Barge Tow	Small	524.95	17,655.27	0.00	18,180.22
Tanker Barge Tow	Large	0.00	38,830.08	0.00	38,830.08
Tanker Barge Tow	Small	3,805.92	73,523.71	0.00	77,329.62
Tug/Tow Boat	Small	274.59	14,269.25	0.00	14,543.84
Totals		5,900.44	233,299.51	0.00	239,199.95

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

Appendix M Zone 13 Philadelphia/Delaware Bay, PA
TABLE 17 Avoided Hazardous Commodity Spills 1996 - 2010 7/30/91

Commodity	Catastrophic	Large	Medium	Small	Total
Candidate Vts Design - Counts					
ALCOHOLS	.00	.00	.00	.00	.00
BENZENE AND TOLUENE	.00	.01	.01	.01	.02
KEROSENE	.00	.00	.00	.00	.01
JET FUEL	.00	.00	.00	.00	.01
DISTILLATE FUEL OIL	.01	.04	.09	1.05	1.19
GASOLINE, INCL NATURAL	.01	.03	.04	.00	.08
RESIDUAL FUEL OIL	.02	.12	.46	.44	1.04
CRUDE PETROLEUM	.04	.11	.12	.01	.27
	.08	.31	.73	1.51	2.62
Existing Vts Design - Counts					
ALCOHOLS	.00	.00	.00	.00	.00
BENZENE AND TOLUENE	.00	.00	.00	.00	.01
KEROSENE	.00	.00	.00	.00	.00
JET FUEL	.00	.00	.00	.00	.00
DISTILLATE FUEL OIL	.00	.02	.04	.17	.23
GASOLINE, INCL NATURAL	.00	.01	.02	.00	.03
RESIDUAL FUEL OIL	.01	.05	.20	.20	.46
CRUDE PETROLEUM	.02	.05	.05	.00	.12
	.03	.13	.32	.37	.86

Note: In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

Appendix M TABLE 18A

Zone 13 Philadelphia/Delaware Bay, PA
Annual Benefit & Cost Streams
Candidate VTS Systems

7/31/91

Discounted to 1993

Year	Investment ($1,000)	Operation & Maintenance ($1,000)	Benefits ($1,000)
1993	8,570	0	0
1996	0	653	1,715
1997	0	593	1,593
1998	0	540	1,479
1999	0	490	1,373
2000	0	446	1,275
2001	0	405	1,187
2002	0	368	1,104
2003	0	335	1,028
2004	0	305	956
2005	0	277	889
2006	0	252	829
2007	0	229	773
2008	0	208	721
2009	0	189	672
2010	0	172	626
	8,570	5,462	16,221

Undiscounted

Year	Investment ($1,000)	Operation & Maintenance ($1,000)	Benefits ($1,000)
1993	8,570	0	0
1996	0	829	2,179
1997	0	829	2,226
1998	0	829	2,274
1999	0	829	2,322
2000	0	829	2,373
2001	0	829	2,428
2002	0	829	2,486
2003	0	829	2,544
2004	0	829	2,602
2005	0	829	2,664
2006	0	829	2,732
2007	0	829	2,804
2008	0	829	2,875
2009	0	829	2,947
2010	0	829	3,022
	8,570	12,441	38,477

Appendix M Zone 13 Philadelphia/Delaware Bay, PA
TABLE 18B Annual Benefit & Cost Streams 7/31/91
Existing VTS Systems

Discounted to 1993

Year	Investment ($1,000)	Operation & Maintenance ($1,000)	Benefits ($1,000)
1993	0	0	0
1996	0	0	700
1997	0	0	650
1998	0	0	604
1999	0	0	561
2000	0	0	522
2001	0	0	486
2002	0	0	452
2003	0	0	421
2004	0	0	392
2005	0	0	365
2006	0	0	340
2007	0	0	318
2008	0	0	296
2009	0	0	276
2010	0	0	258
	0	0	6,643

Undiscounted

Year	Investment ($1,000)	Operation & Maintenance ($1,000)	Benefits ($1,000)
1993	0	0	0
1996	0	0	889
1997	0	0	909
1998	0	0	929
1999	0	0	949
2000	0	0	972
2001	0	0	993
2002	0	0	1,018
2003	0	0	1,042
2004	0	0	1,067
2005	0	0	1,095
2006	0	0	1,122
2007	0	0	1,152
2008	0	0	1,182
2009	0	0	1,212
2010	0	0	1,246
	0	0	15,776

APPENDIX M

ZONE 13 - PHILADELPHIA/DELAWARE BAY, PA

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Philadelphia Port & Subzone	(Port 13) Species Category	Species Code	Species Name	Wildlife Abundance Tables Fish & Shellfish Grams per Square Meter Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
1301	101	1	American Shad	.0043	.0043	.0043	.0043
1301	101	2	Alewife	.2100	.2100	.2100	.2100
1301	102	3	Atl.Menhaden	5.5000	5.5000	5.5000	0.0000
1301	102	4	Atl.Herring	2.2206	0.0000	0.0000	2.2206
1301	102	5	Butterfish	2.3023	2.3023	2.3023	2.3023
1301	102	7	Atlantic Mackerel	25.8966	25.8966	0.0000	0.0000
1301	102	32	King Mackerel	.0190	.0370	.0190	0.0000
1301	102	44	Striped Mullet	.0480	.0480	.0480	.0480
1301	102	127	Silver sides	4.0000	5.0000	7.8000	7.8000
1301	103	8	Bluefish	4.0903	8.1805	8.1805	0.0000
1301	103	9	Striped Bass	.0047	.4700	.0094	.0094
1301	103	10	Monkfish	.0770	.0770	.0770	.0770
1301	103	11	Weakfish	0.0000	5.6333	5.6333	0.0000
1301	104	13	Swordfish	.0330	.0330	.0330	.0330
1301	104	14	Shark	.0041	.0041	.0041	.0041
1301	104	15	Spiny Dogfish	1.7960	1.7960	0.0000	0.0000
1301	105	16	Yellowtail Flounder	1.6655	1.6655	0.0000	0.0000
1301	105	17	Summer Flounder	0.0000	.8327	.8327	0.0000
1301	105	20	Winter Flounder	.0326	0.0000	0.0000	.0326
1301	105	251	Windowpane Flounder	.7837	.2449	.2449	.2449
1301	106	24	Silver Hake	.6900	.6900	.6900	.6900
1301	106	25	Red Hake	.2939	.2939	0.0000	0.0000
1301	106	27	Scup	12.3440	24.6880	24.6880	0.0000
1301	106	28	Tilefish	.0330	.0330	.0330	.0330
1301	106	29	Black Sea Bass	.3921	.3921	.3921	0.0000
1301	106	35	Croaker	0.0000	.0979	.0979	0.0000
1301	106	116	Little Skate	1.7634	0.0000	0.0000	1.7634
1301	106	116	Winter Skate	3.0371	0.0000	0.0000	3.0371
1301	106	199	Other	2.4819	19.2184	35.9549	19.2184
1301	107	201	Surf Clam	1.2000	1.2000	1.2000	1.2000
1301	107	202	Quahog	7.2000	7.2000	7.2000	7.2000
1301	107	203	Atlantic Sea Scallop	.0600	.0600	.0600	.0600
1301	108	204	American Lobster	.1300	.1300	.1300	.1300
1301	108	206	Red Crab	.2300	.2300	.2300	.2300
1301	109	207	Long Fin Squid	0.0000	.0979	.0979	0.0000
1302	101	1	American Shad	.0043	.0043	.0043	.0043
1302	101	2	Alewife	.2100	.2100	.2100	.2100
1302	102	3	Atl.Menhaden	5.5000	5.5000	5.5000	0.0000
1302	102	4	Atl.Herring	2.2206	0.0000	0.0000	2.2206
1302	102	5	Butterfish	2.3023	2.3023	2.3023	2.3023
1302	102	7	Atlantic Mackerel	25.8966	25.8966	0.0000	0.0000
1302	102	32	King Mackerel	.0190	.0370	.0190	0.0000
1302	102	44	Striped Mullet	.0480	.0480	.0480	.0480
1302	102	127	Silver sides	4.0000	5.0000	7.8000	7.8000
1302	103	8	Bluefish	4.0903	8.1805	8.1805	0.0000
1302	103	9	Striped Bass	.0047	.4700	.0094	.0094
1302	103	10	Monkfish	.0770	.0770	.0770	.0770
1302	103	11	Weakfish	0.0000	5.6333	5.6333	0.0000
1302	104	13	Swordfish	.0330	.0330	.0330	.0330
1302	104	14	Shark	.0041	.0041	.0041	.0041
1302	104	15	Spiny Dogfish	1.7960	1.7960	0.0000	0.0000
1302	105	16	Yellowtail Flounder	1.6655	1.6655	0.0000	0.0000
1302	105	17	Summer Flounder	0.0000	.8327	.8327	0.0000
1302	105	20	Winter Flounder	.0326	0.0000	0.0000	.0326

APPENDIX M

ZONE 13 - PHILADELPHIA/DELAWARE BAY, PA (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Philadelphia Port & Subzone	Species Category	(Port 13) Species Code	Species Name	Wildlife Abundance Tables Fish & Shellfish Grams per Square Meter Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
1302	105	251	Windowpane Flounder	.7837	.2449	.2449	.2449
1302	106	24	Silver Hake	.6900	.6900	.6900	.6900
1302	106	25	Red Hake	.2939	.2939	0.0000	0.0000
1302	106	27	Scup	12.3440	24.6880	24.6880	0.0000
1302	106	28	Tilefish	.0330	.0330	.0330	.0330
1302	106	29	Black Sea Bass	.3921	.3921	.3921	0.0000
1302	106	35	Croaker	0.0000	.0979	.0979	0.0000
1302	106	116	Little Skate	1.7634	0.0000	0.0000	1.7634
1302	106	116	Winter Skate	3.0371	0.0000	0.0000	3.0371
1302	106	199	Other	2.4819	19.2184	35.9549	19.2184
1302	107	201	Surf Clam	1.2000	1.2000	1.2000	1.2000
1302	107	202	Quahog	7.2000	7.2000	7.2000	7.2000
1302	107	203	Atlantic Sea Scallop	.0600	.0600	.0600	.0600
1302	108	204	American Lobster	.1300	.1300	.1300	.1300
1302	108	206	Red Crab	.2300	.2300	.2300	.2300
1302	109	207	Long Fin Squid	0.0000	.0979	.0979	0.0000
1303	101	1	Shad	1.1680	1.1680	1.1680	1.1680
1303	101	2	Alewife	.0159	.1069	.1040	.0963
1303	101	2	Blueback Herring	0.0000	.0275	.0097	.0651
1303	101	31	Hickory Shad	.0120	.0060	0.0000	.0060
1303	102	3	Menhaden	22.1000	22.4000	11.2000	0.0000
1303	102	4	Herring	.0010	.0010	.0010	.0010
1303	102	7	Atlantic Mackerel	.0040	0.0000	0.0000	.0040
1303	102	32	King Mackerel	.0030	0.0000	0.0000	.0030
1303	102	33	Spanish Mackerel	.0210	0.0000	0.0000	.0210
1303	102	34	Harvestfish	.0010	.0010	.0010	.0010
1303	102	43	Anchovy	.0050	.3850	.1700	.0050
1303	102	43	Bay Anchovy	0.0000	.0556	.3286	.0872
1303	102	126	Black Crappie	.0024	0.0000	0.0000	0.0000
1303	102	127	Silver sides	4.0000	5.0000	7.8000	.1000
1303	102	127	Tessellated Darter	.0236	.0010	0.0000	0.0000
1303	102	260	Silvery Minnow	.0001	.0001	.0020	.0001
1303	103	8	Bluefish	0.0000	1.3742	1.3742	0.0000
1303	103	9	Striped Bass	0.0000	.0283	.0603	.0407
1303	103	11	Weakfish	1.8322	1.8322	1.8322	0.0000
1303	105	17	Summer Flounder	.0280	.0280	.0280	.0280
1303	105	18	American Plaice	.0170	.0090	.0090	.0100
1303	105	20	Winter Flounder	.0530	.0020	.0700	.0880
1303	106	24	Silver Hake	.0010	.0010	.0010	.0010
1303	106	25	Red Hake	.0040	.0020	.0030	.0030
1303	106	26	White Hake	.0090	.0140	.0050	0.0000
1303	106	29	Black Sea Bass	.0010	.0010	.0010	.0010
1303	106	35	Atlantic Croaker	.3700	.3700	.3700	.3700
1303	106	36	Drum	.0020	.0020	.0020	0.0000
1303	106	37	Spot	.0960	.0490	0.0000	.0490
1303	106	38	Yellow Perch	.0020	.0020	.0020	.0020
1303	106	38	Yellow Perch	.0261	.0780	.0197	.0197
1303	106	39	Carp	.0250	.0250	.0250	.0250
1303	106	40	American Eel	0.0000	.1351	.0664	.0111
1303	106	48	Brown Bullhead	0.0000	.0089	.0155	0.0000
1303	106	48	White Catfish	.0190	.0591	0.0000	.0190
1303	106	120	Naked Gobia	0.0000	0.0000	.0029	0.0000
1303	106	123	White Perch	.0467	.0467	.0467	.0467
1303	106	243	Hogchoker	0.0000	.5359	.3729	.8432

APPENDIX M

ZONE 13 - PHILADELPHIA/DELAWARE BAY, PA (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Philadelphia		(Port 13)		Wildlife Abundance Tables Fish & Shellfish Grams per Square Meter			
Port & Subzone	Species Category	Species Code	Species Name	Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
1303	106	265	Needlefish	0.0000	.2950	0.0000	0.0000
1303	107	211	Soft Clam	.1700	.1700	.1700	.1700
1303	107	212	Oyster	.4970	.4970	.4970	.4970
1303	107	213	Hard Clam	.0800	.0800	.0800	.0800
1303	107	214	Conch	.0660	.0660	.0660	.0660
1303	108	204	American Lobster	.1100	.2200	.1100	0.0000
1303	108	209	Blue Crab	.4310	.4310	.4310	.4310
1303	108	210	Blue Crab	.2000	.2000	0.0000	0.0000
1303	108	217	Horseshoe Crab	.2445	.2445	.2445	.2445
1303	109	207	Squid	.0280	.1500	.1300	0.0000
1304	101	1	Shad	1.1680	1.1680	1.1680	1.1680
1304	101	2	Alewife	.0159	.1069	.1040	.0963
1304	101	2	Blueback Herring	0.0000	.0275	.0097	.0651
1304	101	31	Hickory Shad	.0120	.0060	0.0000	.0060
1304	102	3	Menhaden	22.1000	22.4000	11.2000	0.0000
1304	102	4	Herring	.0010	.0010	.0010	.0010
1304	102	7	Atlantic Mackerel	.0040	0.0000	0.0000	.0040
1304	102	32	King Mackerel	.0030	0.0000	0.0000	.0030
1304	102	33	Spanish Mackerel	.0210	0.0000	0.0000	.0210
1304	102	34	Harvestfish	.0010	.0010	.0010	.0010
1304	102	43	Anchovy	.0050	.3850	.1700	.0050
1304	102	43	Bay Anchovy	0.0000	.0556	.3286	.0872
1304	102	126	Black Crappie	.0024	0.0000	0.0000	0.0000
1304	102	127	Silver sides	4.0000	5.0000	7.8000	.1000
1304	102	127	Tessellated Darter	.0236	.0010	0.0000	0.0000
1304	102	260	Silvery Minnow	.0001	.0001	.0020	.0001
1304	103	8	Bluefish	0.0000	1.3742	1.3742	0.0000
1304	103	9	Striped Bass	0.0000	.0283	.0603	.0407
1304	103	11	Weakfish	1.8322	1.8322	1.8322	0.0000
1304	105	17	Summer Flounder	.0280	.0280	.0280	.0280
1304	105	18	American Plaice	.0170	.0090	.0090	.0100
1304	105	20	Winter Flounder	.0530	.0020	.0700	.0880
1304	106	24	Silver Hake	.0010	.0010	.0010	.0010
1304	106	25	Red Hake	.0040	.0020	.0030	.0030
1304	106	26	White Hake	.0090	.0140	.0050	0.0000
1304	106	29	Black Sea Bass	.0010	.0010	.0010	.0010
1304	106	35	Atlantic Croaker	.3700	.3700	.3700	.3700
1304	106	36	Drum	.0020	.0020	.0020	0.0000
1304	106	37	Spot	.0960	.0490	0.0000	.0490
1304	106	38	Yellow Perch	.0020	.0020	.0020	.0020
1304	106	38	Yellow Perch	.0261	.0780	.0197	.0197
1304	106	39	Carp	.0250	.0250	.0250	.0250
1304	106	40	American Eel	0.0000	.1351	.0664	.0111
1304	106	48	Brown Bullhead	0.0000	.0089	.0155	0.0000
1304	106	48	White Catfish	.0190	.0591	0.0000	.0190
1304	106	120	Naked Gobia	0.0000	0.0000	.0029	0.0000
1304	106	123	White Perch	.0467	.0467	.0467	.0467
1304	106	243	Hogchoker	0.0000	.5359	.3729	.8432
1304	106	265	Needlefish	0.0000	.2950	0.0000	0.0000
1304	107	211	Soft Clam	.1700	.1700	.1700	.1700
1304	107	212	Oyster	.4970	.4970	.4970	.4970
1304	107	213	Hard Clam	.0800	.0800	.0800	.0800
1304	107	214	Conch	.0660	.0660	.0660	.0660
1304	108	204	American Lobster	.1100	.2200	.1100	0.0000

ZONE 13 - PHILADELPHIA/DELAWARE BAY, PA (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Wildlife Abundance Tables
Fish & Shellfish
Grams per Square Meter

Philadelphia (Port 13)

Port & Subzone	Species Category	Species Code	Species Name	Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
1304	108	209	Blue Crab	.4310	.4310	.4310	.4310
1304	108	210	Blue Crab	.2000	.2000	0.0000	0.0000
1304	108	217	Horseshoe Crab	.2445	.2445	.2445	.2445
1304	109	207	Squid	.0280	.1500	.1300	0.0000
1305	101	1	Shad	1.1680	1.1680	1.1680	1.1680
1305	101	2	Alewife	.9900	1.7700	.2400	0.0000
1305	101	2	Blueback Herring	.0800	.1400	.2600	.1400
1305	101	31	Hickory Shad	.0120	.0060	0.0000	.0060
1305	102	3	Menhaden	22.1000	22.4000	11.2000	0.0000
1305	102	4	Herring	.0010	.0010	.0010	.0010
1305	102	7	Atlantic Mackerel	.0040	0.0000	0.0000	.0040
1305	102	32	King Mackerel	.0030	0.0000	0.0000	.0030
1305	102	33	Spanish Mackerel	.0210	0.0000	0.0000	.0210
1305	102	34	Harvestfish	.0010	.0010	.0010	.0010
1305	102	43	Anchovy	.0050	.3850	.1700	.0050
1305	102	126	Black Crappie	.0024	0.0000	0.0000	0.0000
1305	102	127	Silver sides	4.0000	5.0000	7.8000	.1000
1305	102	127	Silverside	.0009	.0009	.0009	.0009
1305	102	127	Tessellated Darter	.0236	.0010	0.0000	0.0000
1305	102	260	Silvery Minnow	.0001	.0001	.0020	.0001
1305	103	8	Bluefish	0.0000	.0190	.0190	0.0000
1305	103	9	Striped Bass	1.8640	.6720	.2320	.2320
1305	103	11	Weakfish	.0330	43.9700	.0295	.0295
1305	105	17	Summer Flounder	.0280	.0280	.0280	.0280
1305	105	18	American Plaice	.0170	.0090	.0090	.0100
1305	105	20	Winter Flounder	.0530	.0020	.0700	.0880
1305	106	24	Silver Hake	.0010	.0010	.0010	.0010
1305	106	25	Red Hake	.0040	.0020	.0030	.0030
1305	106	26	White Hake	.0090	.0140	.0050	0.0000
1305	106	29	Black Sea Bass	.0010	.0010	.0010	.0010
1305	106	35	Atlantic Croaker	.3700	.3700	.3700	.3700
1305	106	36	Drum	.0020	.0020	.0020	0.0000
1305	106	37	Spot	.0960	.0490	0.0000	.0490
1305	106	38	Yellow Perch	.0020	.0020	.0020	.0020
1305	106	38	Yellow Perch	.0261	.0780	.0197	.0197
1305	106	39	Carp	.0250	.0250	.0250	.0250
1305	106	40	American Eel	.1040	.0406	0.0000	0.0000
1305	106	48	Brown Bullhead	13.6900	.1072	.3544	.3544
1305	106	48	Channel Catfish	.1660	.5690	0.0000	.1660
1305	106	48	White Catfish	.0190	.0591	0.0000	.0190
1305	106	120	Naked Gobia	0.0000	0.0000	.0029	0.0000
1305	106	123	White Perch	10.6200	4.4100	2.7900	2.7900
1305	106	243	Hogchoker	.0584	.1280	0.0000	0.0000
1305	106	265	Needlefish	0.0000	.2950	0.0000	0.0000
1305	107	211	Soft Clam	.1700	.1700	.1700	.1700
1305	107	212	Oyster	.4970	.4970	.4970	.4970
1305	107	213	Hard Clam	.0800	.0800	.0800	.0800
1305	107	214	Conch	.0660	.0660	.0660	.0660
1305	108	204	American Lobster	.1100	.2200	.1100	0.0000
1305	108	209	Blue Crab	.4310	.4310	.4310	.4310
1305	108	210	Blue Crab	.2000	.2000	0.0000	0.0000
1305	108	217	Horseshoe Crab	.2445	.2445	.2445	.2445
1305	109	207	Squid	.0280	.1500	.1300	0.0000

APPENDIX M

ZONE 13 - PHILADELPHIA/DELAWARE BAY, PA (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Philadelphia Port & Subzone	Species Category	(Port 13) Species Code	Species Name	Wildlife Abundance Tables Fish & Shellfish Larvae Numbers per Square Meter Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
1301	202	1004	Atlantic Herring	0.0000	0.0000	.3900	0.0000
1301	202	1005	Butterfish	0.0000	5.0000	0.0000	0.0000
1301	202	1007	Atlantic Mackerel	1.9300	1.9300	0.0000	0.0000
1301	202	1043	Anchovy	0.0000	10.0000	1.0000	0.0000
1301	202	1110	Sand Lance	5.0000	0.0000	5.0000	55.0000
1301	202	1128	Searobins	0.0000	5.0000	5.0000	0.0000
1301	203	1008	Bluefish	4.9700	4.9700	4.9700	0.0000
1301	203	1258	Bonito	.4600	.4600	.4600	0.0000
1301	205	1010	Small Mouth Flounder	0.0000	5.0000	.5000	0.0000
1301	205	1016	Yellow Tail Flounder	.5200	.5200	0.0000	0.0000
1301	205	1251	Four Spot Flounder	.9100	.9100	.9100	0.0000
1301	205	1251	Windowpane	.5000	2.5000	5.0000	0.0000
1301	206	1021	Atlantic Cod	.5000	0.0000	0.0000	.5000
1301	206	1025	Hakes	0.0000	5.0000	0.0000	0.0000
1301	206	1035	Atlantic Croaker	0.0000	.6600	.6600	.6600
1301	206	1040	Cuskeel	.5500	.4600	.5500	0.0000
1301	208	1209	Blue Crab	0.0000	572.1538	0.0000	0.0000
1302	202	1004	Atlantic Herring	0.0000	0.0000	.3900	0.0000
1302	202	1005	Butterfish	0.0000	5.0000	0.0000	0.0000
1302	202	1007	Atlantic Mackerel	1.9300	1.9300	0.0000	0.0000
1302	202	1043	Anchovy	0.0000	10.0000	1.0000	0.0000
1302	202	1110	Sand Lance	5.0000	0.0000	5.0000	55.0000
1302	202	1128	Searobins	0.0000	5.0000	5.0000	0.0000
1302	203	1008	Bluefish	4.9700	4.9700	4.9700	0.0000
1302	203	1258	Bonito	.4600	.4600	.4600	0.0000
1302	205	1010	Small Mouth Flounder	0.0000	5.0000	.5000	0.0000
1302	205	1016	Yellow Tail Flounder	.5200	.5200	0.0000	0.0000
1302	205	1251	Four Spot Flounder	.9100	.9100	.9100	0.0000
1302	205	1251	Windowpane	.5000	2.5000	5.0000	0.0000
1302	206	1021	Atlantic Cod	.5000	0.0000	0.0000	.5000
1302	206	1025	Hakes	0.0000	5.0000	0.0000	0.0000
1302	206	1035	Atlantic Croaker	0.0000	.6600	.6600	.6600
1302	206	1040	Cuskeel	.5500	.4600	.5500	0.0000
1302	208	1209	Blue Crab	0.0000	362.0800	0.0000	0.0000
1303	202	1199	Larvae	.1900	.8100	.8100	.2200
1303	203	1199	Larvae	.0110	.1900	.0054	0.0000
1303	205	1199	Larvae	1.1000	.6600	.3600	.0040
1303	206	1199	Larvae	.0270	.4700	1.0400	.0200
1303	207	1199	Larvae	2.0000	20.0000	2.0000	0.0000
1303	208	1199	Larvae	.0016	.0042	0.0000	0.0000
1303	208	1209	Blue Crab	0.0000	46.1363	0.0000	0.0000
1304	202	1199	Larvae	12.4000	52.7000	53.4000	14.3000
1304	203	1199	Larvae	.0640	1.1000	.0310	0.0000
1304	205	1199	Larvae	10.9000	6.5000	3.6000	.0400
1304	206	1199	Larvae	.2100	3.6000	8.0000	.1500
1304	207	1199	Larvae	100.0000	1000.0000	100.0000	0.0000
1304	208	1199	Larvae	.0160	.0420	0.0000	0.0000
1305	202	1199	Larvae	12.4000	52.7000	53.4000	14.3000
1305	203	1199	Larvae	.0640	1.1000	.0310	0.0000
1305	205	1199	Larvae	10.9000	6.5000	3.6000	.0400
1305	206	1199	Larvae	.2100	3.6000	8.0000	.1500
1305	207	1199	Larvae	100.0000	1000.0000	100.0000	0.0000
1305	208	1199	Larvae	.0160	.0420	0.0000	0.0000

ZONE 13 - PHILADELPHIA/DELAWARE BAY, PA (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Philadelphia Port & Subzone	Species Category	(Port 13) Species Code	Species Name	Wildlife Abundance Tables Birds Numbers per Square Kilometer Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
1301	111	517	Common Loon	.7700	0.0000	.0100	.0400
1301	113	531	Gulls	5.6200	.1200	3.8800	3.7300
1301	113	532	Black Legged Kittiwake	.0400	0.0000	.0500	.7700
1301	113	533	Terns	.1400	.1200	.5200	0.0000
1301	113	534	Cory's Shearwater	0.0000	.3000	.3400	0.0000
1301	113	534	Greater Shearwater	0.0000	.6500	.0100	0.0000
1301	113	534	Sooty Shearwater	.0400	.0100	0.0000	0.0000
1301	113	535	Other Jaegers	.0100	.0100	.0200	0.0000
1301	113	535	Parasitic Jaeger	.0100	0.0000	.0300	0.0000
1301	113	535	Pomarine Jaeger	.0200	0.0000	.0700	0.0000
1301	113	535	Skua	.0200	0.0000	0.0000	0.0000
1301	113	537	Storm Petrels	6.0800	1.6400	.1000	0.0000
1301	113	538	Northern Fulmar	.5000	0.0000	0.0000	0.0000
1301	113	542	Other Phalaropes	4.0500	0.0000	.0200	0.0000
1301	113	542	Red Necked Phalarope	.3400	.0200	.4300	0.0000
1301	113	542	Red Phalarope	7.2100	0.0000	0.0000	0.0000
1301	113	547	Northern Gannet	1.5700	0.0000	.2100	.7000
1301	114	583	Manx Shearwater	.0100	.0100	.0100	0.0000
1302	111	517	Common Loon	.7700	0.0000	.0100	.0400
1302	113	531	Gulls	5.6200	.1200	3.8800	3.7300
1302	113	532	Black Legged Kittiwake	.0400	0.0000	.0500	.7700
1302	113	533	Terns	.1400	.1200	.5200	0.0000
1302	113	534	Cory's Shearwater	0.0000	.3000	.3400	0.0000
1302	113	534	Greater Shearwater	0.0000	.6500	.0100	0.0000
1302	113	534	Sooty Shearwater	.0400	.0100	0.0000	0.0000
1302	113	535	Other Jaegers	.0100	.0100	.0200	0.0000
1302	113	535	Parasitic Jaeger	.0100	0.0000	.0300	0.0000
1302	113	535	Pomarine Jaeger	.0200	0.0000	.0700	0.0000
1302	113	535	Skua	.0200	0.0000	0.0000	0.0000
1302	113	537	Storm Petrels	6.0800	1.6400	.1000	0.0000
1302	113	538	Northern Fulmar	.5000	0.0000	0.0000	0.0000
1302	113	542	Other Phalaropes	4.0500	0.0000	.0200	0.0000
1302	113	542	Red Necked Phalarope	.3400	.0200	.4300	0.0000
1302	113	542	Red Phalarope	7.2100	0.0000	0.0000	0.0000
1302	113	547	Northern Gannet	1.5700	0.0000	.2100	.7000
1302	114	584	Manx Shearwater	.0100	.0100	.0100	0.0000
1303	111	511	Duck	160.0000	0.0000	160.0000	320.0000
1303	111	512	Coot	1.6000	0.0000	1.6000	3.1000
1303	111	513	Goose	205.0000	0.0000	205.0000	410.0000
1303	111	514	Swan	20.0000	20.0000	20.0000	20.0000
1303	112	570	Shore Birds	376.0000	144.6000	94.8000	11.7000
1303	113	530	Sea Birds	20.3000	7.6000	8.1000	9.9000
1304	111	511	Duck	160.0000	0.0000	160.0000	320.0000
1304	111	512	Coot	1.6000	0.0000	1.6000	3.1000
1304	111	513	Goose	205.0000	0.0000	205.0000	410.0000
1304	111	514	Swan	20.0000	20.0000	20.0000	20.0000
1304	112	570	Shore Birds	376.0000	144.6000	94.8000	11.7000
1304	113	530	Sea Birds	20.3000	7.6000	8.1000	9.9000
1305	111	511	Duck	160.0000	0.0000	160.0000	320.0000
1305	111	512	Coot	1.6000	0.0000	1.6000	3.1000
1305	111	513	Goose	205.0000	0.0000	205.0000	410.0000
1305	111	514	Swan	20.0000	20.0000	20.0000	20.0000
1305	112	570	Shore Birds	376.0000	144.6000	94.8000	11.7000
1305	113	530	Sea Birds	20.3000	7.6000	8.1000	9.9000

APPENDIX N

SAN FRANCISCO, CA

(ZONE 14)

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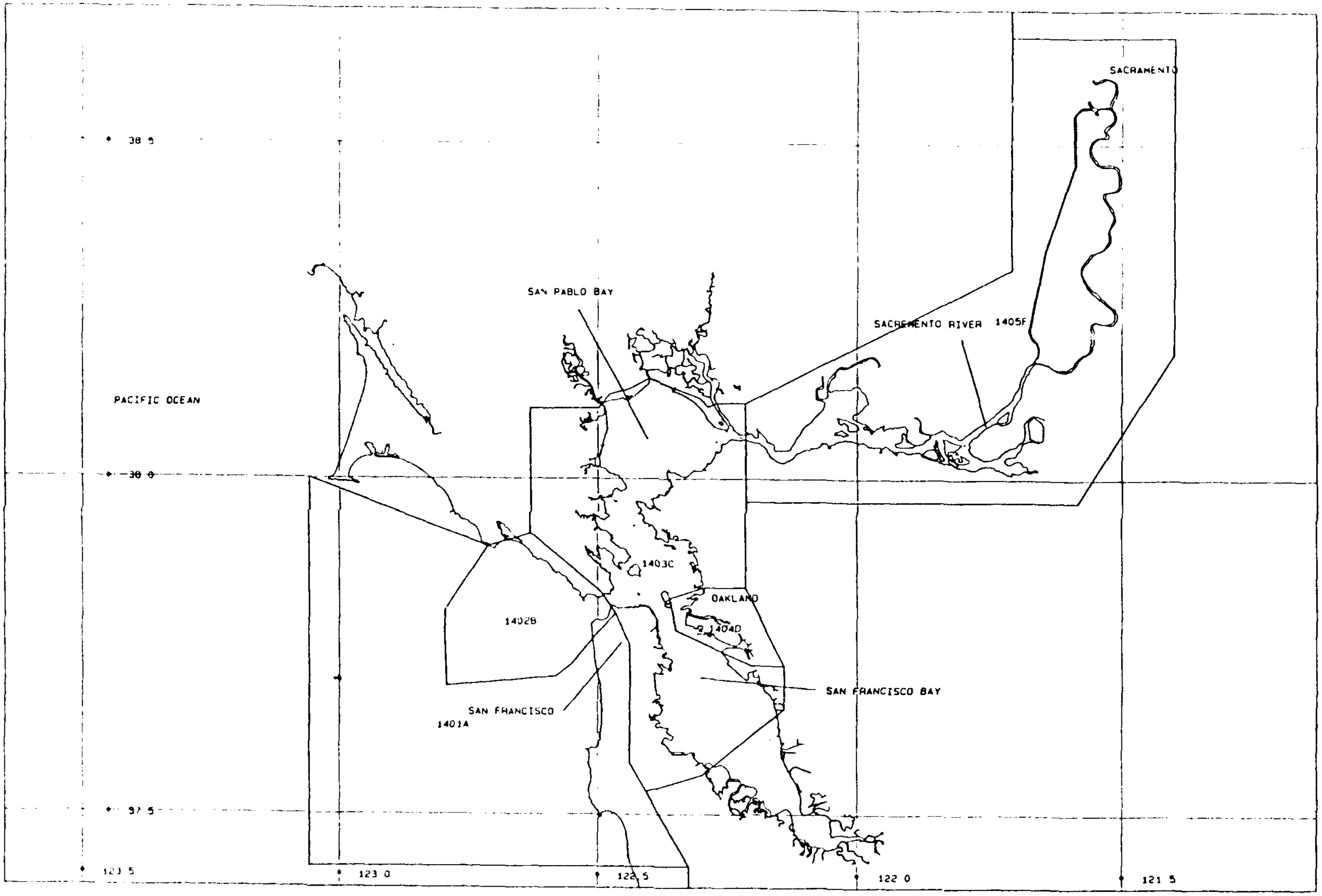
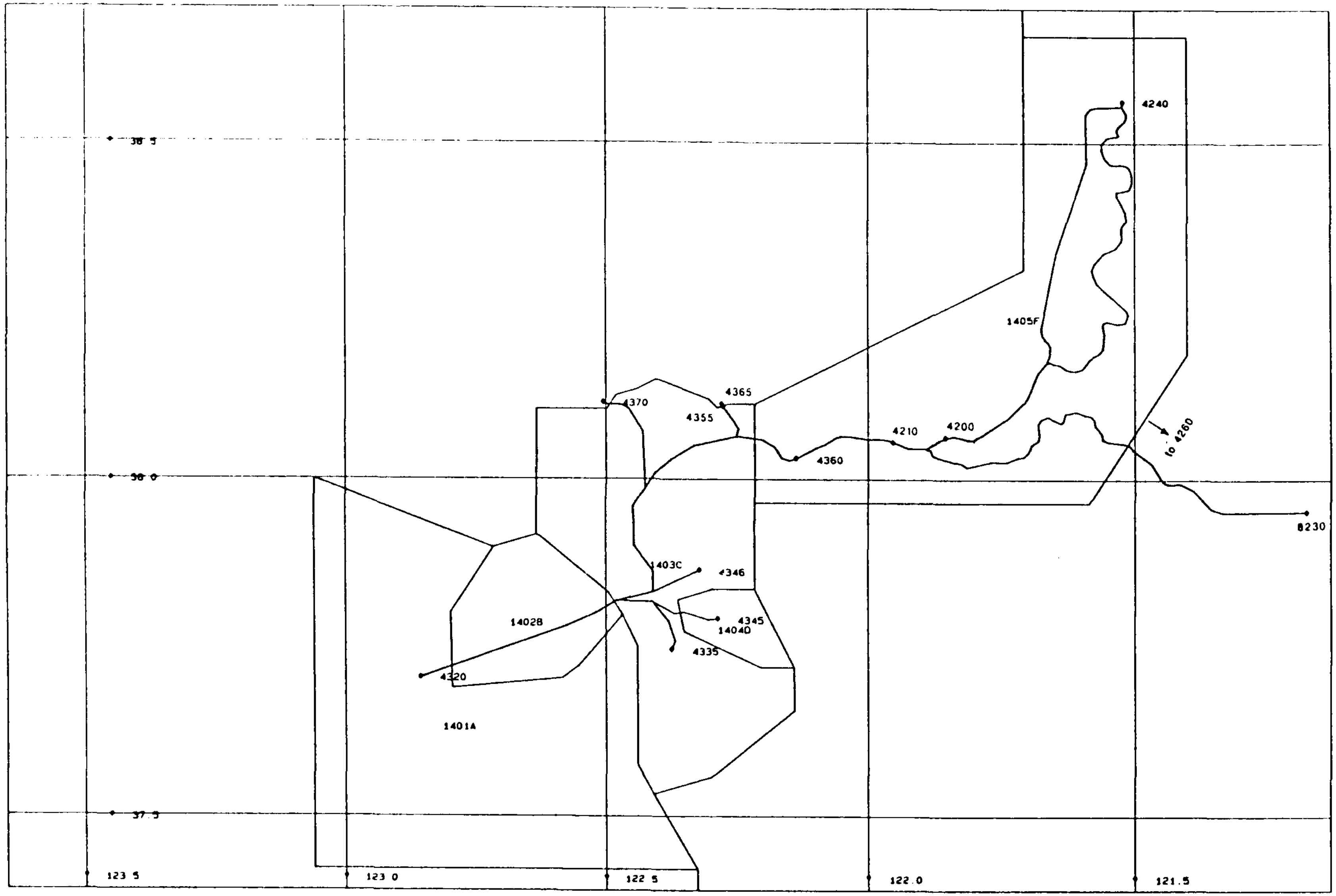
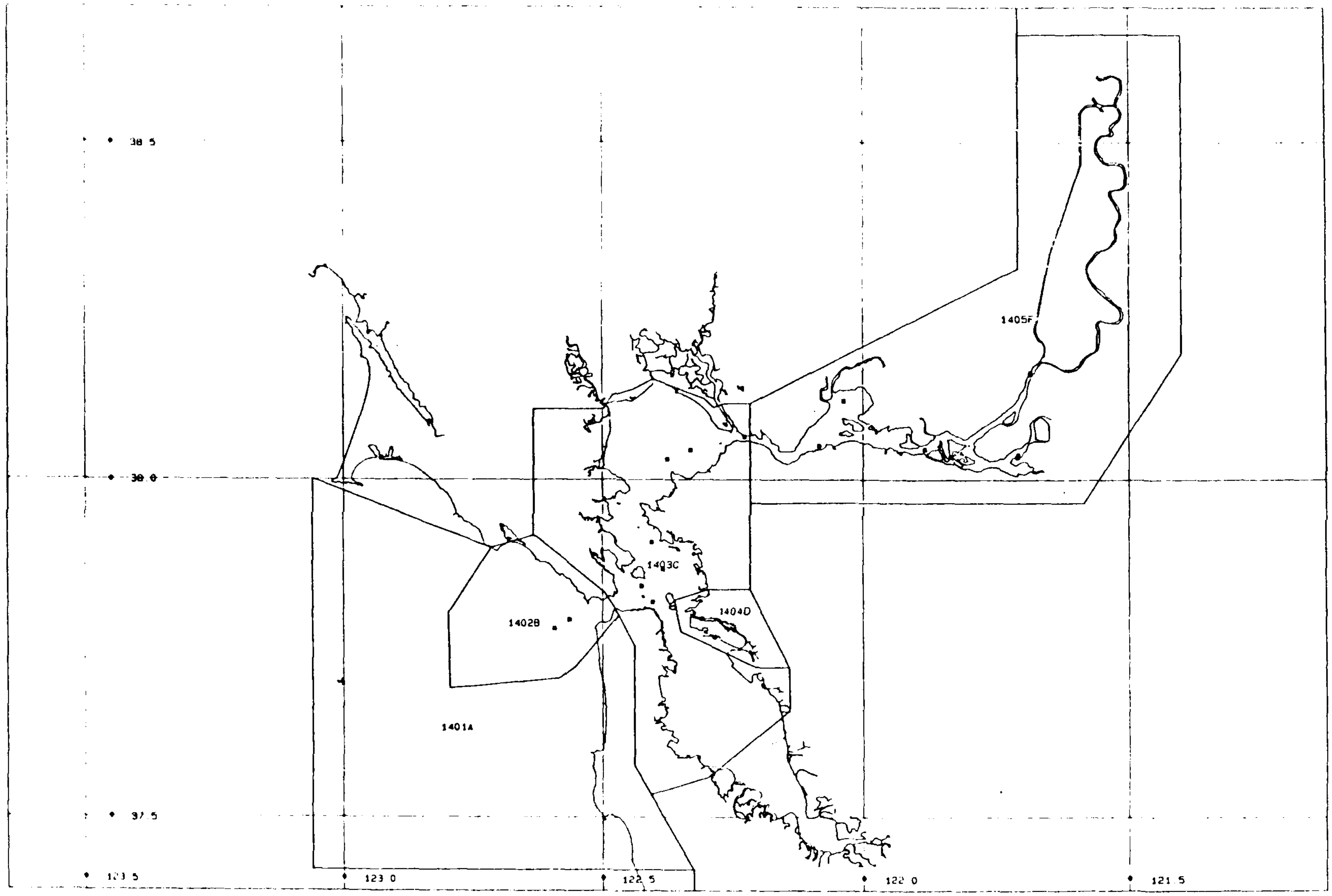
STUDY ZONE MAPS



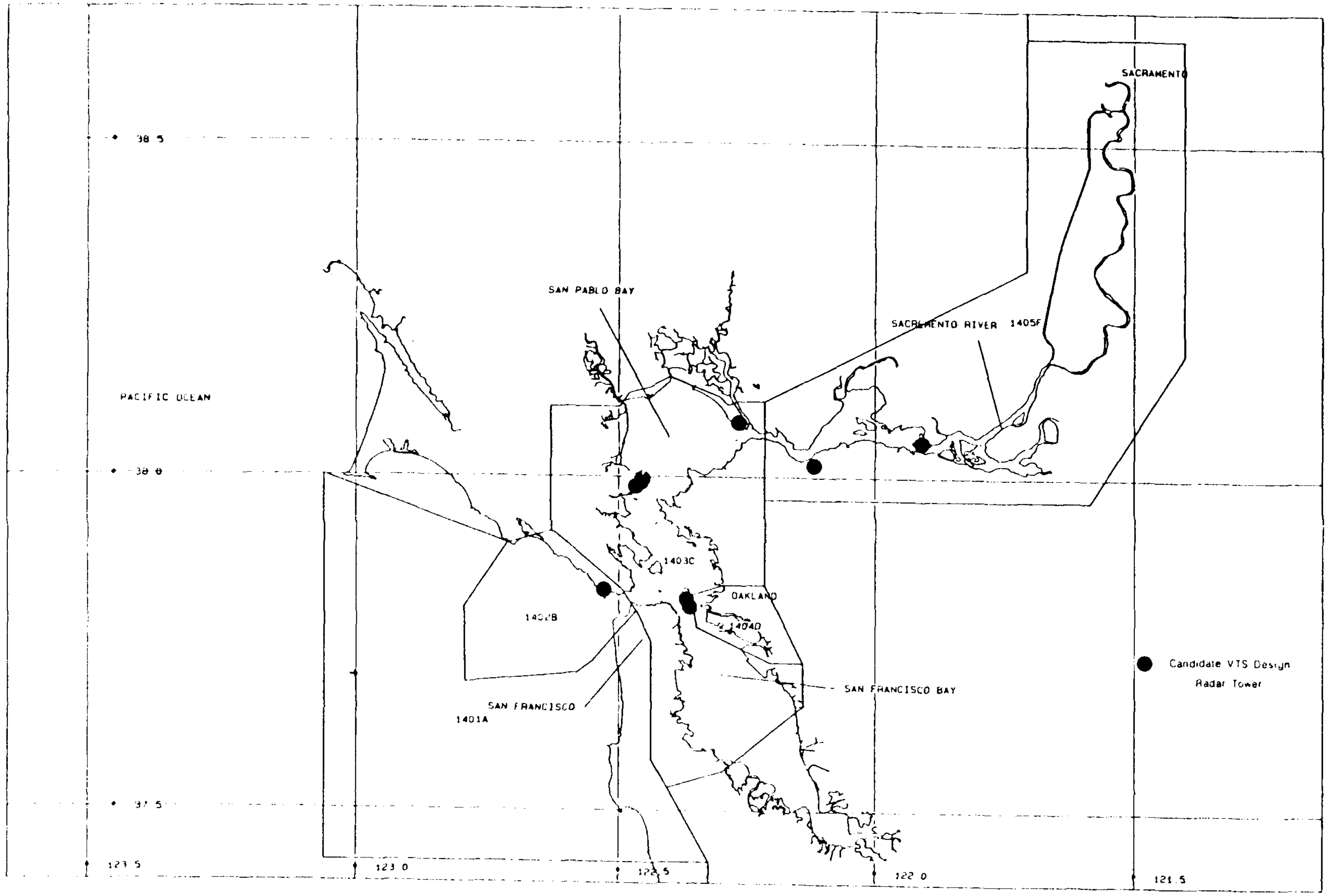
ZONE 14 - SAN FRANCISCO, CA - ZONE AND SUBZONE BOUNDARIES



ZONE 14 - SAN FRANCISCO, CA - DOMINANT VESSEL ROUTES AND COE WATERWAY CODES



ZONE 14 - SAN FRANCISCO, CA - BASE PERIOD (10 YEAR) VESSEL CASUALTIES



ZONE 14 - SAN FRANCISCO, CA - CANDIDATE VTS DESIGN RADAR LOCATIONS

CANDIDATE VTS DESIGN REPORT

FOR

SAN FRANCISCO, CA

(ZONE 14)

Prepared for:
U.S. Department of Transportation
Research and Special Programs Administration
John A. Volpe National Transportation Systems Center
Cambridge, MA 02142

Prepared by:
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July 1991

OVERVIEW

The Candidate VTS Design described in this appendix is one of 23 developed for all the study zones included in the study. This appendix documents the task performed, under Contract DTRS-57-88-C-00088 Technical Task Directive 13, as an integral part of the total Port Needs Study. The ultimate product of this task effort is an informed preliminary technical assessment of the approximate cost to the Federal Government to implement and operate a state-of-the-art VTS system. This appendix does not contain a comprehensive definition of the VTS operating requirements nor does it propose a final VTS specification suitable for implementation.

In order to consistently estimate the life cycle costs of a VTS system in each of the study zones, a "Candidate VTS Design" has been defined for each study zone using a uniform set of design criteria. Each study zone Candidate VTS Design is a composite of generic modules selected from a master list of 18 state-of-the-art surveillance modules, communications and display technology. Among the surveillance modules in the master list are several levels of technical performance from which the selection is made for application to each study subzone to address the local navigational surveillance needs and conditions. The Candidate VTS Design in each study zone represents a consistent application of the surveillance modules at the subzone level. The subzone surveillance technology is subsequently integrated into a total system for the study zone via state-of-the-art communications and display consoles at the Vessel Traffic Center (VTC) in each zone.

The application of the surveillance modules in each subzone responds to the technical requirements of that subzone as perceived by the study team. The Candidate VTS Design represents a preliminary engineering judgement on the appropriate level of technology in each subzone. The Candidate VTS Design may be considered as an informed judgement made by the contractor study team for the sole purpose of developing cost estimates that are consistent across the 23 study zones and suitable for benefit/cost comparisons among the study zones and initial budget planning and implementation priorities. The approach used to calculate VTS system costs for all 23 study zones is found in Volume III, Technical Supplement.

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APPENDIX

PORT OF SAN FRANCISCO VTS SURVEY

1.0 SCOPE

This report includes a port survey and a VTS design for San Francisco, California. The port survey is based on a review of all pertinent literature including navigational charts. The methodology used to produce the VTS design entails coupling the problems identified in the port survey with solutions offered by state-of-the-art technology as identified in the VTS Technology Survey, November 1990. When possible, technological advances which permit manpower reductions are applied. Not all VTS problems are amenable to strictly technological solutions; some require changes in procedures and/or enforcement. These situations are identified where they occur.

2.0 PORT OF SAN FRANCISCO SURVEY

2.1 INTRODUCTION

This survey report is based exclusively upon review of available literature and examination of the charts for the port and its approaches. The information thus gained has been evaluated and interpreted based upon the Survey Team's experience as professional mariners and in vessel traffic management systems. The study, in general terms, encompasses the Ports of the San Francisco Bay area, the Golden Gate and its seaward approaches, and those portions of the Bay area waterways covered by the existing San Francisco VTS.

The Survey Area is one of the principal harbors on the Pacific coast of the United States, and consists of a series of connecting bays and harbors of which San Francisco Bay, San Pablo Bay and Suisun Bay are the largest. The area ranks as the fifth largest port in the U. S. in terms of crude oil handled, and sixth in terms of refined oil (Reference 1).

The region around the Bay is heavily populated, and this is reflected in the volume of recreational boating on its waters. Much of the area inside the entrance is environmentally sensitive wetlands, and the coastal area of the Approaches supports important fisheries. Point Reyes, immediately to the north of the entrance, and the Farallon Islands are designated as a National Marine Sanctuary to protect and preserve resident birds and mammals.

The San Francisco Bay area is served by a U. S. Coast Guard (USCG) operated Vessel Traffic Service (VTS) and an Offshore Vessel Movement Reporting System (OVMRS).

2.2 OVERVIEW OF THE PORT

The climate of the San Francisco Bay area is moderate, tempered by the Pacific Ocean and the water mass of the Bay and its tributaries. Particularly during the summer months the Bay is prone to winds which increase in intensity throughout the day and fall at night. This is because the prevailing onshore flow is strengthened by the heating and rising of air over the hinterlands east of the Bay. The effect dies in the evening, as the land mass cools with the onset of darkness.

Fog is a problem throughout the area particularly in and around the Golden Gate. Fog is common in summer, occasional in winter and infrequent during the spring. Conditions during summer can also combine to cause a semi-permanent fog bank off the coast. The Coast Pilot shows an average of 4.8 days of fog per month throughout the year, but its data does not address visibility inside the Golden Gate. Other reports place the incidence of fog at about 150 days per year (Reference 2).

The diurnal tidal range at the Golden Gate is 5.8 feet, but a range of up to nine feet can occur at the times of maximum tides. Tidal ranges in the inner reaches are as small as three feet. There are strong tidal currents at various points throughout the area, with velocities exceeding six knots at some places. Detailed information is available from the Tidal Current Tables and the Tidal Current Charts for San Francisco Bay. Current-imposed set and drift are important navigational factors for Bay shipping.

The approach to the port is through an established TSS which is well marked by visual aids. In addition, Loran-C coverage for the approach area is excellent. It should be noted, however, that topography may create anomalies in Loran-C readings from the Golden Gate inward. Hazards throughout the Study Area are well marked, and radar returns from the islands, bridges and the bold north shore of the Bay provide excellent navigational references. Currents are significant throughout and must be considered in the navigational process. Poor visibility occurs frequently enough to be a significant factor in traffic management throughout the year. Federal Projects maintain channels inland as far as Sacramento, and appropriate charts should be consulted for tabulations of depths and widths.

Pilotage is compulsory for all foreign-flag vessels and U. S. ships under enrollment with no federal licensed pilot on board. Pilotage is provided by the San Francisco Bar Pilots, who handle shipping to and from all of the ports on San Francisco Bay and its tributaries, including Stockton and Sacramento. Pilots board inbound ships in the vicinity of San Francisco Approach Lighted Horn Buoy SF. Pilot boats guard VHF-FM Channels 10, 13, 16 and 18A, and their office ashore monitors Channel 10.

Facilities within the Study Area support a wide mix of traffic, ranging from petroleum ships to passenger vessels. Hazardous cargoes consist of both industrial material, such as anhydrous ammonia, and miliary munitions. The Bay area has a considerable volume of intrabay commercial traffic, including dredges and other floating plants, and weekend recreational use is heavy. The U. S. Army Corps of Engineers Port Series Reports provide a detailed description of the area's facilities and "The Golden Gate Atlas", published annually by the San Francisco Bay Marine Exchange, provides an excellent overview of the area's marine activities.

2.3 EXISTING TRAFFIC MANAGEMENT

A significant number of regulations, procedures and facilities exist for the management of vessel traffic within San Francisco Bay and its approaches. This report discusses the more significant management measures. A detailed discussion is contained in the Coast Pilot (Reference 3).

2.3.1. General Management Problems

Several problems complicate traffic management. Many mariners report communications congestion of Channel 13, with delays of up to two minutes while waiting to transmit (Reference 4). Additional problems are conflict between deep-draft and local vessels especially small craft failure to yield the right of way to channel-constrained vessels.

2.3.2 Offshore Vessel Movement Reporting System (OVMRS)

An Offshore Vessel Movement Reporting System, similar to the VMRS utilized inside the Port, covers the ocean approaches to San Francisco Bay out to 38 miles offshore. Voluntary in nature, all deep-draft ships are asked to report their movements to VTS San Francisco. The VTS guards VHF-FM Channel 16 and works on Channel **12. Ships are asked to report their type, name, position, route,** speed, and estimated times of arrival (ETA) at designated reporting points. (See CCGD12 Notice to Mariners No. 46 of 13 November 1986 for designated reporting points, OVMRS limits, and other details.)

2.3.3 San Francisco Traffic Separation Scheme (TSS)

An International Maritime Organization (IMO) sanctioned TSS exists in the ocean approaches to San Francisco Bay, consisting of **Directed Traffic Areas** each with one-way **inbound and outbound Traffic Lanes** separated by defined **Separation Zones**; a **Precautionary Area** and a **Pilot Boat Cruising Area**.

While recommended for ships approaching or departing San Francisco Bay, the TSS is not intended for tugs, tows, or other small vessels which traditionally operate outside of the usual shipping lanes or close inshore. Ships which are not calling at San Francisco are urged to pass the San Francisco Bay approaches to the west of the

Farallon Islands to avoid crossing the **Directed Traffic Areas** and the **Precautionary Area**.

2.3.4 Traffic Routing System (TRS)

The **TRS** is established in the VTS area seaward of the Golden Gate, the Main Ship Channel and in San Francisco Bay, north of Hunters Point and south of Carquinez Strait. The TRS consists of one-way **Traffic Lanes** separated by **Separation Lines.** Traffic proceeds within the lanes in the direction which holds the Separation Line on the port side of the vessel. **Precautionary Areas, Limited Traffic Areas (LTA)**, and **Recreation Areas** also are included in the TRS which is not IMO sanctioned.

The VTS encourages use of the **Limited Traffic Area** south of Yerba Buena Island by one vessel at a time or by vessels proceeding generally in the same direction. The VTC carefully monitors and evaluates deviations particularly for vessels of 300 gross tons or over and may direct action if meeting and passing situations cannot be resolved between participants themselves.

The Pinole Shoal Channel in San Pablo Bay is considered to be a one-way channel whenever an explosive or hazardous material laden vessel, or a vessel with a draft of over 30 feet, is transiting.

A **Deep Draft Route** runs eastbound in the westbound lane from east of the Golden Gate, north of Harding Rock and Alcatraz Island, east of Blossom Rock, then through C-D or D-E span of the Oakland Bay Bridge to Anchorage 9. The VTC must be notified by Masters or Pilots intending to use this route. The VTS will notify other traffic and may make a Marine Safety Broadcast on Channels 16 and 22A to announce impending deviations in the TRS. U.S. Coast Guard (USCG) escorts may be provided during periods of heavy traffic congestion.

2.3.5 Vessel Traffic Service, San Francisco

VTS San Francisco serves San Francisco Bay, its seaward approaches and its tributaries inland to Stockton and Sacramento. The Vessel Traffic Center (VTC) associated with the VTS is continuously manned by the Coast Guard. The VTS maintains communications with vessels via VHF-FM (Channel 13) and monitors the position and movement of vessels by position reports and radar. Voice radio communications forms the backbone of VTS operations.

The VTS is voluntary and is recommended for all vessels over 300 Gross Tons (GT) and other vessels subject to the Vessel Bridge-to-Bridge Radiotelephone Regulations (Reference 5). Participation in the VTS is mandatory under certain conditions of weather and for dangerous cargoes, and may become a mandatory system in the near future. Recreational craft are asked to monitor VHF-FM Channel 13 to obtain vessel movement information of interest to them.

The VTS assists mariners by providing advice, helping to insure that unavoidable meetings and crossing situations take place under the most favorable conditions, by relaying navigational safety information, and by encouraging the mutual planning for meetings and crossings via bridge-to-bridge radiotelephone.

Part of the VTS area is covered by radar and part is not, thereby requiring different procedures to be followed depending upon where a vessel is located. The radar surveillance area comprises the traffic lanes of the San Francisco TSS (see 2.3.3 above), the main ship channel through Golden Gate, and the central part of San Francisco Bay south of Point San Pablo and north of the San Mateo-Hayward Bridge. Within the radar surveillance area vessels are automatically tracked and are asked to report to the VTC by radiotelephone:

When entering the surveillance area from seaward or when getting underway from within the area;

When passing under any bridge within the area, upon completion of a pilot change or other change in person directing movement of the vessel;

When previously reported conditions or intentions change;

When intending to deviate from the TSS or VTS;

In emergencies;

And to report any condition considered to be a hazard to navigation.

In addition to the significant portion of the VTS area of responsibility that is not covered by radar surveillance, there are numerous radar blind spots due to shadowing by the various islands. The VTS requested that radar surveillance be extended into San Pablo Bay from San Pablo Strait through Carquinez Strait to the Benicia-Martinez Bridge. This would include Pinole Shoal Channel.

North of Point San Pablo and south of the San Mateo-Hayward Bridge there is no radar coverage and the VTS depends upon the Vessel Movement Reporting System (VMRS) which utilizes radiotelephone reporting by participating vessels. Participants are asked to report to the VTC:

When preparing to get underway from within the area;

When actually getting underway;

In the northern portion of the area at Point San Pablo, Carquinez Bridge, the Southern Pacific Railroad Bridge across Carquinez Strait, New York Point, Rio Vista Bridge across the Sacramento River, Sacramento River Deep Water Ship Channel Light 51, Sacramento, Antioch Bridge across the San Joaquin River, Prisoners Point, and Stockton;

When entering or leaving the Petaluma River entrance channel or Mare Island Strait;

In the southern portion of the area at Hunters Point, San Mateo-Hayward Bridge;

When previously reported conditions change;

In emergencies;

And to report any condition considered to be a hazard to navigation.

The VTS administers the anchorages in the VTS area on behalf of the USCG Captain of the Port (COTP), San Francisco pursuant to Title 33, Code of Federal Regulations, Section 110.224. The VTC observes the anchorages with radar, plots vessel positions from time to time, reports observed problems, and provides "reasonable assistance" to pilots when anchoring. The VTS accepts Title 33 compliance reports.

The VTS is divided into two Sectors, each with a control position in the VTC. The "Offshore Sector" Extends beyond the Precautionary Area surrounding Sea Buoy "SF" 40 miles north to Bodega Head, 30 miles south to Pescadero Point and out 30 miles from "SF". communications on VHF-FM CH12 In this area, the Sector Operator utilizes the Point Bonita radar to track vessels through much of the offshore area. The "Offshore Sector" is responsible for handling the OVMRS which is relied upon for managing the traffic outside radar coverage. Traffic management within the Precautionary Area is the responsibility of the Offshore Sector. This Area is unique in that is represents the transition of Sectors and a change in the VTS communications Channel from 12 to 13.

The "Inshore Sector" extends from the Precautionary Area through the South Bay to Redwood City and north to the Ports of Stockton and Sacramento. In the area between the Richmond-San Rafael Bridge and the San Bruno Bridge, the Sector Operator utilizes the Yerba Buena Island (YBI) and the Point Bonita radars to track vessels. In the area south to Redwood City and from the Richmond Bridge north to Sacramento and Stockton, the Vessel Movement Reporting System (VMRS) is utilized to manage traffic. The Inshore Sector also has responsibility to be cognizant of what is occurring in the "SF" thereby facilitating the handoff.

The VTC exchanges all "traffic" information with active VTS participants on Channel 13. Recreation vessels and other "non-participants" are encouraged to monitor Channel 13, if so equipped, otherwise to use Channel 16 to call the VTC and shift to another VTS Channel (ie, Channel 12). Channel 12 also is used to receive OVMRS reports. The VTC **does not** maintain Channel 16 guard for active participants.

Low power level transceiver sites appropriately located through the VTS area would reduce interference on all channels and permit occasional Channel 13 communications with participants without interfering with bridge-to-bridge communications throughout the Bay Area.

Vessel Status Cards are initiated for each participant and are physically located on the radar consoles relative to their approximate positions in the Bay. Special cards and notations are used for multi-trip participants, vessels moving contrary to the established traffic rules, and other purposes.

The VTS imposes special rules (some with COTP authority) for conditions such as low visibility, non-standard procedures, Deep Draft Vessels, SpeciaL Interest Vessels (SIV), and vessels carrying hazardous cargoes.

A Status Board is maintained in the VTC to keep track of VHF-FM equipment status, anchorages, telephone numbers, moored vessels, scheduled arrivals/departures, SIV's and weather information.

During periods of heavy fog between the Sea Buoy "SF" and Alcatraz Island, and when there is shipping in that area, a separate "Fog Watch" Sector is activated with a dedicated PPI for tracking and managing traffic in that area(s). All vessels within the fog-bound area are treated as though they are Participants in the VTS, thereby temporarily creating a Mandatory VTS.

2.3.5.1 Existing VTS Technology

Two radars provide surveillance. One, located at Point Bonita outside the entrance to the Golden Gate, covers the South, Main and North Approach Channels, the seaward Precautionary Area and the Main Ship Channel traffic lanes to the Golden Gate. This radar is a modified AN/SPS-64 (V) shipboard type radar. The second radar, an AN/FPS-121, is installed in duplicate at YBI and covers that portion of the VTS Area north of the San Mateo Bridge and south of Point San Pablo. Radar video is sent back to the VTC via microwave and displayed on Raytheon RAYCAS (Raytheon Collision Avoidance System) V displays.

A few years ago the original AIL VTS radars were replaced with modified shipboard Raytheon radars.

Recently, Closed Circuit Television (CCTV) cameras have been installed atop the tower at Yerba Buena Island (near VTC). One of the cameras is a Low Light Level (LLTV) type. These cameras reportedly have provided the VTC with valuable surveillance information on traffic moving in the Limited Traffic Area (LTA) of Oakland's Inner and Outer Harbor Entrance Channel. CCTV video is sent to the VTC via a microwave link. Additional CCTV coverage has been requested for the confluence of Mare Island Strait and Carquinez Strait, for the reach between the Benicia and Southern Pacific Bridges to Pittsburgh, and for the Pinole Shoal Channel.

The Vessel Traffic Center (VTC) maintains VHF-FM radio communications for the entire VTS on Channels 12, 13, and 16 from four separate transmitting/receiving sites. A pair of 6 channel transceivers on CH12, CH13, CH16. CH18A, CH21A and CH22A with guard receivers on CH13 and CH16 are installed at each site. They are controlled from the VTC through Motorola Centracom units in the Sector and Supervisor consoles. Although these transmitters should be capable of operating on low (1-watt) power, it cannot be confirmed that the VTC utilizes them in that mode.

These high level VHF-FM sites are:

Yerba Buena Island (VTC): provides communications for the YBI radar coverage area which is from the Pilot area to San Pablo Bay. The VTC backup generator provides emergency power.

Mt. Tamalpais: provides OVMRS communications and is backup for other sites. Emergency power is provided by the Army Corps of Engineers facility.

Point Bonita: provides communications for OVMRS, the Pilot area and central San Francisco Bay. A backup generator provides emergency power.

TV Hill: located east of Suisun Bay near the Naval Ammunition Facility at Port Chicago provides communications for the VMRS area at the end of San Pablo Bay and for the Ports of Stockton and Sacramento. A backup generator provides backup power.

The VTC exchanges all "traffic" information with active VTS participants on Channel 13. Recreation vessels and other "non-participants" are encouraged to monitor Channel 13 if so equipped otherwise to use Channel 16 to call the VTC and shift to another VTS Channel (ie, Channel 12). Channel 12 also is used to receive OVMRS reports. The VTC **does not** maintain Channel 16 guard for active participants.

In the VTC, five standard (non-raster scan) radar PPI's are available for use by the watchstanders/supervisor, in addition to the newer CCTV displays and controls. There normally are two watchstanders and one supervisor on watch in the VTC. The watch force is a mixture of military and civilian. One Sector operator (a GS-9 or Petty Officer) handles the Central Bay, utilizing VHF-FM CH13. The other Sector operator is the Offshore (OVMRS) Controller and utilizes VHF-FM CH12, CH13, and CH16. The Supervisor position is manned by a commissioned officer, Chief Petty Officer or a GS-11 civilian employee. A Dictaphone 9000, 20-channel audio tape recorder is installed in the VTC to record the VHF-FM voice channels as well as telephone conversations.

2.3.6 Narrow Channels and Fairways

The Captain of the Port (COTP) has identified specific areas which are considered to be narrow channels or fairways for the purpose of enforcing the International and Inland Rules of the Road. While the listing is not exhaustive it does serve to identify deep-draft navigation areas where small craft can impede the safe transit of larger vessels if care is not exercised. Narrow channels, COLREGS Rule 9 applies. The listing is published in the Coast Pilot (Reference 6).

2.3.7 Special Anchorage Rule

The COTP has ordered that all ships greater than 300 GT anchored in San Francisco Bay must maintain a radio listening watch on Channel 13 when the wind velocity exceeds 20 knots, or on Channel 16 if Channel 13 is not available. The watch must be maintained by English-speaking personnel. Vessels are prohibited from anchoring in the navigable waters outside established anchorages except in emergency and then must stay clear of all traffic lanes. The deeper portions of anchorages are reserved for deeper draft vessels.

2.3.8 Local Authorities

The Port of San Francisco is under control of the City of San Francisco, which exercises jurisdiction through Port-issued Harbor Regulations.

2.3.9 Carriage of Explosives and Certain Hazardous Bulk Cargoes

In addition to regulations established elsewhere, the COTP has issued supplemental regulations to govern ships carrying Class A or Military explosives and certain hazardous bulk cargoes. Those carrying a net explosive weight exceeding 100 tons for ships and 5 tons for barges may be escorted by the Coast Guard while within the Bay. Transits will not be made at speeds over 12 knots, nor will transits be made when the visibility is less than one mile. 24 hour notice of arrival is required and the ships/barges shall participate in the VTS and adhere to the TSS.

2.4 VESSEL TRAFFIC

One source of statistics, which counted only traffic to Richmond and the Carquinez Strait area, placed San Francisco Bay as the fifth largest handler of crude oil in the United States and sixth largest of petroleum products (gasoline, jet fuel and fuel oil, Reference 7).

Extensive statistics are maintained by the San Francisco Bay Marine Exchange. Although a review of their data indicates that there may some duplication, with the possibility that arrivals at anchorages appear again as arrivals at specific ports, the resulting distortion should not significantly change its traffic management implications. Overall, commercial and government ship arrivals for the Bay area stand at about 4000 per year and have remained at or near that plateau for several years.

Distribution of those arrivals by location within the Bay area is critical to traffic management planning and, based upon historic data it seems clear from that data that, in descending order of priority, attention should focus on the following:

1. The Main Ship Channel and Golden Gate Channel, since all deep-draft traffic transits them.

2. Anchorages throughout the Study Area.

3. The Port of Oakland, and its approaches from Golden Gate.

4. Carquinez Strait and Suisun Bay, together with their approaches from Golden Gate.

5. The Port of Richmond, including the facilities either side of the Richmond-San Rafael Bridge, together with the approaches from Golden Gate.

6. The Port of San Francisco, and its approaches.

(Note: Traffic bound for several of these areas combine, thereby increasing the volume in their common approaches.)

Approximately 25% of the arrivals are tankers, and 10+% appear to be container ships. In addition to this traffic, records of the San Francisco VTS show about 6800 intrabay moves per month. Some 65% of the intrabay traffic consists of passenger ferries.

2.5 ENVIRONMENTAL SENSITIVITY

The entire Study Area, including the seaward approaches, must be considered as environmentally sensitive, and there is high public interest in maintaining or improving the ecosystems of San Francisco Bay.

In the approaches, the Point Reyes area and the Farallon Islands form a National Marine Sanctuary administered by the National Oceanic and Atmospheric Administration (NOAA). Within the Bay the northern and southern reaches contain wetlands of marked importance to migratory aquatic birds and the Bay supports small but important fisheries. The Marin Peninsula emphasizes the quality of life created by its waterfront, and there is heavy recreational use of the entire area.

The "Worst Case" pollution incident is probably a massive spill of crude oil as the result of a collision of a tanker and another vessel, although the same results are possible from a grounding on one of the rocks located throughout San Francisco Bay. Tidal action and the strong currents can complicate containment and permit both natural and human habitats to be affected. Although less likely because of the precautions taken, the catastrophic detonation of a munitions ship could potentially have major impact upon populated areas.

2.6 PORT SUB-ZONES

The port was examined to determine appropriate sub-zones, using a methodology based upon the "confined-complex", "open-complex", "confined-simple" and "open-simple" system employed by the Canadian VTS study in 1984 (Reference 8). Briefly stated, "open" and "confined" address the influence of geography upon a ship's ability to maneuver and "simple" vs "complex" is descriptive of the nature of the interactions between ships within those geographic areas. This basic matrix was overlaid by a subjective assessment of appropriate traffic management/risk amelioration measures in order to derive sub-regions within which VTS needs are homogeneous.

2.6.1 Sub-Zone I -- Ocean Approaches. (NOAA Charts 18020 & 18640)

This sub-zone is defined to seaward by a line between the following points: Bodega Head Light, 38^0-10'N 123^0-30'W, 37^0-50'N 123^0-30'W, 37^0-11'N 122^0-50'W, Pescadero Point Light. The inshore limit is a line connecting Point Reyes Light, Farallon Islands Light and Point Montara Light.

This sub-zone approximately corresponds to the present **Offshore Sector** of the San Francisco VTS and the region covered by the Offshore Vessel Movement Reporting System. Coastwise shipping not calling at San Francisco will, if they follow the guidance in the Coast Pilot (Reference 9), generally remain to seaward of Sub-Zone I.

Traffic management requirements within this sub-zone can be met through reporting procedures, coupled with acquisition of inbound traffic by surveillance sensors prior to passing into Sub-zone II. Automatic Direction Finder (ADF) capability will assist in the identification and acquisition process.

The sub-zone is classified as "open-simple."

2.6.2 Sub-Zone II -- Gulf of the Farallons (NOAA Chart 18640)

This sub-zone is defined to seaward by the limits of Sub-zone I (a line connecting Point Reyes Light, Farallon Islands Light and Point Montara Light), and inshore by the COLREGS Demarcation Line at the entrance to Golden Gate.

The sub-zone includes all of the San Francisco TSS, the Pilot Boarding Area, and the beginning of the additional TSS serving San Francisco Bay. The VTS should be capable of providing positional assistance, if required, and of facilitating a smooth and safe traffic flow through the TSS Precautionary Area.

The sub-zone is considered "confined-complex." The confining restrictions imposed upon maneuvering are the strictures of the TSS, and complex interactions are possible within the Precautionary Area.

2.6.3 Sub-Zone III -- San Francisco Bay (NOAA Chart 18649)

This sub-zone is defined on the west by the COLREGS Demarcation Zone at the entrance to the Golden Gate. The northern boundary is formed by the Richmond-San Rafael Bridge and the southern limits by a line between the Coit Tower (San Francisco) and the cupola on Treasure Island. Those portions of the Port of Richmond south of the Richmond-San Rafael Bridge are included in the sub-zone.

The southern limits of the sub-zone north of the Oakland Bridge were placed to insure that the entrance to the Port of Oakland did not fall into two sub-zones.

Important management requirements within this sub-zone include the capability to manage the anchorages, including surveillance and position-fixing of ships within them; to provide navigation assistance to vessels within the TSS; and to facilitate the smooth and safe flow of traffic through the TSS and its Precautionary Area.

The sub-zone is considered "confined-complex."

2.6.4 Sub-Zone IV. San Pablo Bay. (NOAA Charts 18649, 18654, 18656)

This sub-zone is defined to the south by the Richmond-San Rafael Bridge and to the east by a line drawn due south from Dillon Point. It includes Mare Island Straits, that portion of the Port of Richmond above the Richmond-San Rafael Bridge, and a portion of Carquinez Strait.

The eastern boundary was deliberately established at Dillon Point to include the critical area around the Interstate Route 80 Bridge and the Mare Island Strait junction within a single sub-zone.

Important requirements within this sub-zone include the capability to manage the anchorages, including surveillance and position-fixing of the ships within them; to provide navigation assistance to vessels within the TSS; and to facilitate the smooth and safe flow of traffic to and from the port facilities within the sub-zone.

The sub-zone is considered "confined-complex."

2.6.5 Sub-Zone V -- Carquinez Strait/Suisun Bay. (NOAA Chart 18656)

This sub-zone lies between a line drawn due south from Dillon Point and 121^0-50'W.

The primary management concerns in this sub-zone is the management of traffic through the narrow Project channels within it.

The sub-zone is considered "confined-complex."

2.6.6 Sub-Zone VI -- Sacramento River. (NOAA Chart 18661)

This sub-zone consists of that portion of the Sacramento River and associated waterways east of 121^0-50' W.

The sub-zone is one of light deep-water traffic and can be managed under normal conditions by reporting procedures and information management.

The sub-zone is considered "confined-complex."

2.6.7 Sub-Zone VII -- Lower San Francisco Bay. (NOAA Chart 18650 and 18651)

This sub-zone consists of that portion of San Francisco Bay lying between a line between the Coit Tower (San Francisco) and the cupola on Treasure Island, and the San Mateo-Hayward Bridge.

Important management requirements within this sub-zone include the capability to manage the anchorages, including surveillance and position-fixing of ships within them; to provide navigation assistance to vessels within the TSS; and to facilitate the smooth and safe flow of traffic to and from the port facilities within the sub-zone.

The sub-zone is considered "confined-complex."

2.6.8 Sub-Zone VIII -- Redwood Creek. (NOAA Chart 18651)

This sub-zone includes that portion of San Francisco Bay and its tributaries lying south of the San Mateo-Hayward Bridge.

The sub-zone is one of light deep-water traffic and can be managed under normal conditions by reporting procedures and information management.

The sub-zone is considered "confined-complex."

2.7 PROBLEM AREA IDENTIFIERS

2.7.1 PAI II-1. Precautionary Area

The Precautionary Area is the point of convergence of the three TSS routes to and from sea, and the main channel to Golden Gate. In addition to the convergence, near-center of the Precautionary Area is also the pilot boarding area. VTS capabilities should include provision of position-fixing assistance, if required; and the ability to assist the smooth and safe melding of traffic.

2.7.2 PAI III-1. Alcatraz Shoal

The area between the Marin Peninsula and San Francisco in the vicinity of Alcatraz Shoal is, in addition to being the main deep-water route to and from sea, crossed by ferries and local San Francisco-Marine County traffic. The northern and southern portions contain designated "recreational areas", heavily used by recreational boaters, and these inevitably intrude into the shipping lanes. Tour boats and sightseeing excursions, including trips to Alcatraz Island increase the potential for interaction between vessels. Ferries operating between Piers 41 and 43 1/2 and Marin County (Sausalito and Tiberon) also transit this area. An eastbound deep-draft route uses the westbound traffic lane through a portion of this PAI.

VTS capabilities should include provision of position-fixing assistance, if required; and the ability to assist the smooth and safe movement of traffic. The ability to identify vessels over 300 GT intruding into recreational areas, or small craft which intrude upon narrow fairways or channels.

2.7.3 PAI III-2. Precautionary Area

The Precautionary area east of Alcatraz Island is the junction of the three principle deep-water channels serving the Bay area. An eastbound deep-draft route uses the westbound traffic lane through a portion of this PAI. Commuter ferries operating between the San Francisco Ferry Terminal and Vallejo, Larkspur and Tiberon/Sausalito transit this area.

VTS capabilities should include position-fixing assistance, if required; and the ability to assist the smooth and safe movement of traffic. The ability to identify vessels over 300 GT intruding into recreational areas, or small craft which intrude upon narrow fairways or channels.

2.7.4 PAI III-3. Raccoon Strait

Raccoon Strait is a recreational area, closed to vessels over 300 GT, and vessels within it are in a radar shadow with respect to north- and southbound ships using the Precautionary Area-San Pablo point legs of the Traffic Routing System. Commuter ferries operating between the San Francisco Ferry Terminal and Larkspur transit this area.

The VTS should possess the capability to detect vessels within Raccoon Strait which may impinge upon the TRS, and will ideally possess the ability to identify shipping over 300 GT using the Strait in violation of its recreational area designation.

2.7.5 PAI III-4. Southampton Shoal Channel

Southampton Shoal Channel is 600' in width throughout its length and is used by shipping to and from the facilities of the Port of Richmond.

VTS capabilities should include provision of position-fixing assistance, if required; and the ability to assist the smooth and safe movement of traffic. This includes queuing ships in- and outbound from Richmond facilities, if required.

2.7.6 PAI III-5. Paradise Cay

The TRS east of Paradise Cay contains a significant course change and, for northbound traffic, the approach to the Richmond - San Rafael Bridge.

VTS capabilities should include provision of position-fixing assistance, if required and the ability to assist the smooth and safe movement of traffic. This includes queuing ships in- and outbound through this section of the waterway, if required.

2.7.7 PAI III-6. Point Potrero Turn

The Point Potrero Turn, within the Port of Richmond, requires considerable maneuvering and tug assistance for large ships to negotiate. Deep-draft ships should not meet at the turn, and smaller traffic should be kept clear of maneuvering ships.

VTS capabilities should include provision of position-fixing assistance, if required; and the ability to assist the smooth and safe movement of traffic. This includes queuing ships in- and outbound through this section of the waterway, if required.

2.7.8 PAI IV-1. Point San Pablo

The TRS between the Richmond-San Rafael Bridge and Point San Pablo offers some navigational challenges: Southbound shipping must negotiate a course change and ship for passage beneath the bridge; and northbound traffic must stay within the proper lane while shaping for Pinole Channel and clearing the hazards of Invincible Rock, Whiting Rock and The Brothers. Ships may also be maneuvering to make and clear facilities at Point San Pablo, Molate Point and Castro Point. Commuter ferries and excursion trips operating between Vallejo and San Francisco (Ferry Terminal and Piers 41, 43 1/2) transit this area.

VTS capabilities should include provision of position-fixing assistance, if required, and the ability to assist the smooth and safe movement of traffic. This includes queuing ships in- and outbound through this section of the waterway, if required.

2.7.9 PAI IV-2. Pinole Shoal

The VTS treats the Pinole Channel as one-way for the transit of ships drawing over 30', and for those carrying explosives or hazardous material. Commuter ferries and excursion trips operating between Vallejo and San Francisco (Ferry Terminal and Piers 41, 43 1/2) transit this area.

VTS capabilities should include provision of position-fixing assistance, if required, and the ability to assist the smooth and safe movement of traffic. This includes queuing ships in- and outbound through this section of the waterway, if required.

2.7.10 PAI IV-3. Mare Island Junction

"The confluence of Mare Island Strait and Carquinez Strait is a major choke point. It screams for radar and CCTV coverage. There are crossing ferries, trawling fishermen, dredge disposals, recreational boaters, submarine traffic, and tankers moored at Oleum dangerously close to the main stream. Carquinez Strait is a tricky passage. Currents are swift; recreational fishermen often anchor in the channel; and ships must shape up quickly to clear the Benicia and Southern Pacific Bridges." (Reference 10). Commuter

ferries and excursion trips operating between Vallejo and San Francisco (Ferry Terminal and Piers 41, 43 1/2) transit this area.

VTS capabilities should include provision of position-fixing assistance, if required, and the ability to assist the smooth and safe movement of traffic. This includes queuing ships in- and outbound through this section of the waterway, if required.

2.7.11 PAI V-1. Roe Island Channel

The area to which this PAI applies represents a difficult stretch of channel, with strong currents and is subject to heavy fog during the winter months.

Although much of the channel is too narrow for navigational assistance in terms of cross-track location, an along-track assistance capability will contribute to queuing, if that is required. Surveillance will provide the capability to furnish shipping with information necessary to prevent surprise encounters.

2.7.12 PAI V-2. Pittsburg

The PAI represents a difficult stretch of channel, with strong currents and one subject to heavy tule fog during winter months. It is also a junction point where traffic flows separate and merge.

Although much of the channel is too narrow for navigational assistance in terms of cross-track location, an along-track assistance capability will contribute to queuing, if that is required. Surveillance will provide the capability to furnish shipping with information necessary to prevent surprise encounters.

2.7.13 PAI VII-1. Oakland Junction

A **Limited Traffic Area** exists south of Yerba Island that should be used by only one major vessel at a time or by vessels proceeding generally in the same direction, thus reducing the potential for interactions between vessels at or near the entrances to Oakland and Alameda. An eastbound deepdraft route between the sea and General Anchorage No. 9 uses the westbound traffic lane through a portion of this PAI. Heavy recreational boating exists in this PAI, especially during weekends. Commuter ferries operating between the San Francisco Ferry Terminal and Oakland-Alameda transit this area.

VTS capabilities should include provision of position-fixing assistance, if required; and the ability to assist the smooth and safe movement of traffic. This includes queuing ships in- and outbound to and from Oakland and Alameda, if required.

2.7.14 PAI VII-2. Oakland Middle and Inner Harbors

The present VTS commanding officer considers the capability to keep the Inner and Middle harbors of Oakland essential to providing pilots and ships moving within the Port of Oakland properly advised.

Although channels are too narrow for navigational assistance in terms of cross-track location, surveillance will provide the capability to furnish shipping with information necessary to prevent surprise encounters.

3.0 PORT OF SAN FRANCISCO VTS DESIGN

3.1 INTRODUCTION

A detailed survey of the Port of San Francisco is the basis for this design. An approach to costing VTS systems is outlined in Vol. III, Technical Supplement and a method of categorizing surveillance sensors into "modules" has also been developed. These modules are defined in terms of cost and performance and are to be applied to all VTS designs in this study. The applicability of Automatic Dependent Surveillance (ADS) technology is also discussed in this report. The eight sub-zones defined in the harbor survey remain the same.

Traffic management requirements for each sub-zone are developed from PAI analysis. Table 3-1 lists in tabular form a summation of the problems identified and the management required by sub-zone.

The hardware and software selected for this design provide the level of surveillance justified by the problems identified in each sub-zone. A secondary consideration is to locate all VTS assets so that they are sufficient for the sub-zone in question and can contribute to adjoining sub-zones to achieve maximum usage. All specific equipments are then selected based on perceived surveillance requirements and overall VTS system architecture.

TABLE 3-1. SAN FRANCISCO, CA PROBLEM AREA IDENTIFIERS

PAI	LOCATION	PROBLEM	MANAGEMENT
I	Ocean Approaches	Potential vessel interactions	Have real-time knowledge of both participant and non-participant locations and movement. Be able to correlate all movement, provide movement management advice. Identify inbound radar targets.
II	Gulf of the Faraliones	Potential congestions and dissimilar traffic	Same As Above plus provide navigational assistance.
III	San Francisco Bay	Congestion, random movements, dissimilar traffic and non-participants. Traffic queuing to and from Richmond may be required. Anchorage management required.	Same As Above. Manage anchorages.
IV	San Pablo Bay	Congestion, dissimilar traffic, large numbers of non-participants. Anchorage management required.	Same As II Above.

TABLE 3-1. SAN FRANCISCO, CA PROBLEM AREA IDENTIFIERS (Cont.)

PAI	LOCATION	PROBLEM	MANAGEMENT
V	Carquinez Strait/Suisun Bay	Narrow channels introduce risk of incidents especially during low visibility.	Have real-time knowledge of both participant and non-participant locations and movement. Be able to correlate all movements, provide movement management advice.
VI	Sacramento River	Narrow channels introduce risk of incidents.	Have knowledge of participant movement. Be able to correlate these movements, provide management advice and alerting.
VII	Lower San Francisco Bay	Congestion, random movements, dissimilar traffic and non-participants. Anchorage management required.	Same As V Above plus manage anchorages.
VIII	Redwood Creek	Movements into SZ VII must be introduced into the VTS system.	Same As VI Above.

3.1.1 VTS Design Approach

The choice of surveillance sensors is dependent on the VTS mission. For the purposes of this design, the VTS mission is defined as that which insures the safety of navigation and the protection of the environment. In order to accomplish this mission, mandatory participation of all vessels over 20 meters is essential. The Vessel Traffic Center (VTC) must provide navigation safety advice to all vessels. The VTS in the United States will have no facilitation of commerce role nor will it offer piloting assistance of any kind.

The primary criteria for selection of adequate surveillance sensors are:

- o Percentage of vessels of the desired minimum size detected in designated surveillance areas

- o Percentage of lost tracks

- o Accuracy of the position and track obtained

- o Reliability of the surveillance system
- o Timeliness of the data obtained

- o Ability to interpret and use the data obtained

Secondary criteria are:

- o Cost of the VTS system -- reduction of manpower by the use of technology

- o Expandability -- increased VTS responsibility, area, and/or support of other missions

Active surveillance sensors including radar, communications, and closed circuit television (CCTV) installations are used when detection and tracking of vessels is paramount to providing safety advice. These devices are considered fail safe in that it is known with certainty when they have failed. The performance characteristics of these sensors are known from operational VTS worldwide experience. In this design they are selected to assure that the necessary operational criteria identified for each sub-zone is realized.

Many dependent surveillance techniques are possible. These range from voice radio reporting of required VTS data to automatic position and identification recording devices that can be interrogated from shore known as Automatic Dependent Surveillance (ADS) devices. The position and/or movement reporting form of dependent surveillance is used extensively in existing VTS systems. The major regions of current use are those which do not require

active surveillance. To apply ADS technology to a specific sub-zone within a VTS zone the following additional criteria must be considered:

o The number and class of vessels interacting in the sub-zone and which of these interactions are important to the VTS mission. Obviously all vessel classes of interest must be appropriately equipped. This requires that all vessels of the classes selected which will ever pass through this sub-zone must be equipped with an ADS device. This requirement to detect so many different vessels argues against the use of ADS. In areas where only one class of vessel is of interest, ADS is more easily implemented.

o The interactions or transits to be monitored must not demand that the surveillance be fail safe, i.e. positively detecting failures. This type of surveillance is related to position reporting in that it may not always function or be used properly and the VTS has limited control over its operation.

o It must be determined that if active surveillance is not justified, the additional information obtained from ADS over position reporting is necessary.

o If the class or group of vessels to be monitored is a "controllable" group, ADS can be easily implemented and satisfactory operation more readily achieved. Controllable means a clearly defined subset of vessels, e.g. a specific barge company; vessels carrying a specific cargo, etc.

o The number of different vessels in each class of interest that passes through the sub-zone in question must be determined. This number must be known to accurately estimate the cost of selecting this option for this sub-zone.

o A specific ADS solution for one sub-zone in one harbor may affect all the VTS designs for all the other sub-zones in all the other harbors.

3.1.2 Assumptions

The design of this VTS system starts with a set of assumptions based on the detailed survey and other data. These assumptions are as follows:

o As recommended by the IMO, all vessels of 20 meters or more in length are required to participate in the VTS. Participation is defined (at a minimum) as monitoring the VTS frequency and reporting as required.

- The VTS system is implemented with the cooperation and assistance of the port authorities, pilots associations, and marine exchange, if any. The existing facilities, services, and procedures established and operated by these organizations are major elements of an integrated VTS system as defined in the IMO VTS Guidelines.

- The life-cycle of all system hardware is ten years.

3.2 DESIGN DECISIONS (FIGURE 3-1)

3.2.1 General

Examination of the traffic levels, geographical features and identified problem areas in this port leads to the following selection and location of sensor hardware.

3.2.2 Hardware Location and Selection

3.2.2.1 Sub-Zone II

Point Bonita Site	1 Module 3 radar 1 Module 4 radar 1 Module 13 MET 1 Module 16 DF
Mt. Tamalpais Site	1 Module 10 VHF 1 Module 11 VHF

3.2.2.2 Sub-Zone III

Richmond Site	1 Module 18 CCTV 1 Module 10 VHF 1 Module 13 MET

3.2.2.3 Sub-Zone IV

Point San Pedro Site	1 Module 1 radar 1 Module 10 VHF 1 Module 13 MET
Mare Island Site	1 Module 1 radar 1 Module 10 VHF 1 Module 11 VHF

Surveillance Modules -Sub Zones	RADAR						ADS			VHF		MET.		HYD.		DF	CCTV		COMMENTS
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
I																			Required radar/DF coverage also from Sub-zone II
II			1	1						1	1		1			1			
III							25			1			1					1	
IV	2									2	1		1						
V	2									1			1						
VI										3	1								
VII	1	1								1	1	1		1					
VIII										1									

FIGURE 3-1. SAN FRANCISCO, CA SURVEILLANCE SURVEY

3.2.2.4 Sub-Zone V

Martines Site	1 Module 1 radar
Suisun Bay Site	1 Module 1 radar 1 Module 10 VHF 1 Module 13 MET

3.2.2.5 Sub-Zone VI

Rio Vista Site	1 Module 10 VHF
Sacramento Site	1 Module 10 VHF
Vorden Site	1 Module 10 VHF 1 Module 11 VHF

3.2.2.6 Sub-Zone VII

Yerba Buena Site	1 Module 1 radar 1 Module 2 radar 1 Module 10 VHF 1 Module 12 MET 1 Module 14 HYD

3.2.3 Vessel Traffic Center

The design of the hardware and software should be modern and capable of operating with reduced staff levels and no loss of effectiveness. Two watchstanders and a watch supervisor with integrated data workstations and decision aiding software can effectively manage the activity in this port. This Vessel Traffic Center concept demands that the watchstanders be separated from any other harbor/port information requests. The Center must be structured so that such requests are controlled by a bulletin board type interface. One Commanding Officer, one Executive Officer and one clerk are also required fcr the proper administration of the facility.

The Vessel Traffic Center is located on Yerba Buena Island in a location with good visual surveillance of the San Francisco Bay. The center is to employ the following equipment:

3.2.3.1 VTS Console

This console provides total data integration from all sensors in all sectors. These data are graphically shown on raster scan, high light level, color displays. A data display is also provided. Console design architecture is general purpose computer based, open architecture, bus organized, allowing operation of the system as a local area network (LAN). Data interchange with other facilities

by modem is provided as well as interface with the U.S. Coast Guard standard terminal. The design allows board level modification and expansion. Features of the software and hardware provided are:

- o Software written in a high level language.

- o Software providing the total integration of data from all VTS sensors.

- o Layering of data in at least four layers to be operator selectable.

- o The ability to sector data including sector to sector handoff of targets.

- o The ability to accept external digital data derived from transmissions of shipboard transponders or other sources and integrate the information with all other sensor data.

- o Automatic and/or manual acquisition of radar targets including automatic tracking and target ID assignments. Guard zones with automatic acquisition of all targets entering the zone.

- o Several warning levels of vessel interaction designed to direct attention to developing situations rather than a simple CPA alarm strategy.

- o Complete vessel monitoring and alarm capability including anchor watch, CPA, TCPA, track history, adjustable target velocity vectors, restricted area penetration and maneuvering monitor is provided. Additional warning and/or alarm features allowed by programming changes in high level language.

- o Complete modern color graphics capability with offset and zoom

- o Complete harbor navigation aid monitoring capability including buoy position, light status, etc.

- o Remote control of all radars and radar interfaces as well as radar data processing including site-to-site integration, clutter suppression, scan conversion and target extraction.

- o Complete track projection capability which can predict and/or analyze future interactions based on current position, destination and velocity.

- The capability of constructing a complete vessel data base and interfacing it to the real-time data display from the VTS sensors.

3.2.3.2 Communications Console

This console is capable of remotely operating the proposed transmitting/receiving sites and allowing transmission and monitoring on all required frequencies. The console provides three operating positions each to be capable of complete communications control. It is capable of modular expansion if other remote communications sites are added.

3.2.3.3 Supervisor Control and Data Acquisition (SCADA) Equipment

A SCADA capability is provided to the major module level at remote sites so that the watchstander can determine the status of the entire VTS system. A graphic readout is provided in block diagram form indicating operational status of all elements in the system. Security monitoring of remote sites is also included.

3.2.3.4 Recording Equipment

Time synchronized video and audio recording equipment is to be provided. This equipment is capable of recording and playing back the data presented to the VTS watchstander and his reaction to the situation. An extra set of recording equipment is to be installed for redundancy purposes.

3.3 COST ESTIMATES

3.3.1 General

Appendix A discusses a generalized approach to estimating VTS system costs. This approach is based on interviews with system designers and purchasers of recently constructed systems. The cost of this VTS system has been estimated using this approach and is detailed below. The assumptions made in estimating these costs are listed in Paragraph 3.1.2.

3.3.2 Hardware Costs (x $1000)

Vessel Traffic Center	non-recurring	recurring(10-yr)
VTS Console (2 workstations one supervisory console & all software)	1000	
Recording Equipment	100	
SCADA Equipment (11 radar sites)	1000	
Comms console	200	
Sub-total:	2300	1000

Sub-Zone I--Ocean Approaches (NOAA Charts 18020 & 18640)

Required comms DF and radar coverage provided from Sub-Zone II.

Sub-Zone II--Gulf of the Farallons (NOAA Chart 18640)

1 Module 3 radar	400	400
1 Module 4 radar	400	400
1 Module 10 VHF	19	13
1 Module 11 VHF	48	20
1 Module 13 MET	40	5
1 Module 16 DF	90	5
Sub-total:	997	843

Sub-Zone III--San Francisco Bay (NOAA Chart 18649)

1 Module 10 VHF	19	13
1 Module 13 MET	40	5
1 Module 18 CCTV	117	50
Sub-total:	176	68

Sub-Zone IV--San Pablo Bay (NOAA Charts 18649, 18654 & 18656)

2 Module 1 radars	620	620
2 Module 10 VHF	38	26
1 Module 11 VHF	48	20
1 Module 13 MET	40	5
Sub-total:	746	671

Sub-Zone V--Carquinez Strait/Suisun Bay (NOAA Chart 18656)

2 Module 1 radar	620	620
1 Module 10 VHF	19	13
1 Module 13 MET	40	5
Sub-total:	679	638

Sub-Zone VI--Sacramento River (NOAA Chart 18661)

3 Module 10 VHF	57	39
1 Module 11 VHF	48	20
Sub-total:	105	59

Sub-Zone VII--Lower San Francisco Bay (NOAA Chart 18650 & 18651)

1 Module 1 radar	310	310
1 Module 2 radar	310	310
1 Module 11 VHF	48	20
1 Module 10 VHF	19	13
1 Module 12 MET	20	5
1 Module 14 HYD	10	2
Sub-total:	717	660

Sub-Zone VIII--Redwood Creek (NOAA Chart 18651)

1 Module 10 VHF	19	13
Sub-total:	19	13
HARDWARE TOTALS:	5739	3952

3.3.3 Project Totals (x $1000)

Non-recurring

Hardware	5739
Management, Engineering, etc. (55%) Assumptions: Turnkey system, Procurement by integ.contractor, good manufacturer support, some software provided, System Manual required	3156
Installation site integration (20%) Assumptions: Complete installation by contractor, remote access no serious problem, many widespread sites	1148
Spares & Training (10%)	574
Civil Engineering 6 remote radar sites, many remote comms and WX sensor installations, some land acquisition, new VTC building on Yerba Buena Island	3000
PROJECT ESTIMATE:	13617
Data Base Management System	300
TOTAL: (non-recurring)	$ 13917

Recurring (10 year)

Hardware	3952
2 Watchstanders x 5 = 10 man/years @ 50K x 10	5000
1 Watch Supervisor	2500
1 Commanding Officer	500
1 Executive Officer	500
1 Clerk	500
TOTAL: (recurring) (10-year life)	$ 12952
TOTAL 10-YEAR PROJECT COST:	$ 26869

REFERENCES

1. Summary Statistics on Leading U. S. Ports, Center for Marine Conservation, Washington, D. C. 22 March 1990

2. Port Visits to San Francisco, Portland, Oregon, and Cook Inlet, Alaska during the week of August 13-17, 1990, Robert Ricci, Transportation Systems Center, Cambridge, 4 September 1990.

3. United States Coast Pilot, Pacific Coast: California, Oregon, Washington, and Hawaii, 25th Edition, NOAA, Washington, D. C., Pp. 152-194.

4. Interview, Commanding Officer, VTS San Francisco, 10 October 1990.

5. See 33CFR 26.03 for specific requirements.

6. United States Coast Pilot, Pacific Coast: California, Oregon, Washington, and Hawaii, 25th Edition, NOAA, Washington, D. C., Pg. 152.

7. Summary Statistics on Leading U. S. Ports, Center for Marine Conservation, Washington, D. C. 22 March 1990.

8. Final Report, National Vessel Traffic Services Study (TP5965E), Canadian Coast Guard, Ottawa, October 1984, Pp. 89-91.

9. United States Coast Pilot, Pacific Coast: California, Oregon, Washington, and Hawaii, 25th Edition, NOAA, Washington, D. C., Pg. 152.

10. Co, VTS San Francisco ltr 16630 of 10 May 1990 to Commandant (G-N).

GLOSSARY

ADS: Automatic Dependent Surveillance

ARPA: Automatic Radar Plotting Aid.

"CONFINED-COMPLEX": a combination of terms relating to the geography and the nature of the interactions between ships. See Final Report National Vessel Traffic Services Study (TP-5965E), Canadian Coast Guard, Ottawa, October 1984, pp.89-91.

"CONFINED-SIMPLE": a combination terms relating to the geography and the nature of the interactions between ships. See Final Report National Vessel Traffic Services Study (TP-5965E), Canadian Coast Guard, Ottawa, October 1984, pp.89-91.

COTP: Captain of the Port

CCTV: closed circuit television

COLREGS LINE: a demarcation line delineating those waters upon which international regulations for the prevention of collisions at sea apply.

C' \: closest point of approach

DBMS: data base management system

DF: direction finder

FAA: Federal Aviation Administration

GIS: Geographic Information System

ICW: Intracoastal Waterway

IMO: International Maritime Organization

KW: Kilowatt

LAN: local area network

LLOYD'S LIST: a listing of all merchant vessels of the world including their physical characteristics. Published by Lloyd's of London.

LNG: liquified natural gas

NOAA: National Oceanic and Atmospheric Administration

"OPEN-COMPLEX": a combination of terms relating to the geography and the nature of the interactions between ships. See Final Report National Vessel Traffic Services Study (TP-5965E), Canadian Coast Guard, Ottawa, October 1984, pp. 89-91.

"OPEN-SIMPLE": a combination of terms relating to the geography and the nature of the interactions between ships. See Final Report National Vessel Traffic Services Study (TP-5965E), Canadian Coast Guard, Ottawa, October 1984, pp. 89-91.

PAI: Problem Area Identifier

PRECAUTIONARY AREA: an area normally an intersection, entrance to, or exit from a traffic separation scheme where vessel interactions are unpredictable

SCADA: Supervisor Control and Data Acquisition

TCPA: time of closest point of approach

TRAFFIC SEPARATION SCHEME: routes incorporating traffic separation to increase the safety of navigation, particularly in converging areas of high traffic density.

VHF: very high frequency

VTC: vessel traffic center

VTS: vessel traffic services

APPENDIX

ADDITIONAL COST REQUIRED FOR ADDING SURVEILLANCE EQUIPMENT

PORT OF SAN FRANCISCO (Using 2 Existing USCG Radars)

1.0 HARDWARE COSTS (x $1000)

Vessel Traffic Center	non-recurring	recurring(10-yr)
VTS Console (2 workstations one supervisory console & all software)	1000	
Recording Equipment	100	
SCADA Equipment (11 radar sites)	1000	
Sub-total:	2100	1000

Sub-Zone I--Ocean Approaches (NOAA Charts 18020 & 18640)

Required comms DF and radar coverage provided from Sub-Zone II.

Sub-Zone II--Gulf of the Farallons (NOAA Chart 18640)

1 Module 3 radar	400	400
1 Module 4 radar	400	400
1 Module 13 MET	40	5
1 Module 16 DF	90	5
Sub-total:	930	810

Sub-Zone III--San Francisco Bay (NOAA Chart 18649)

2 Module 1 radars	620	620
1 Module 2 radar	310	310
2 Module 10 VHF	38	26
1 Module 12 MET	20	5
1 Module 13 MET	40	5
1 Module 14 HYD	10	2
1 Module 18 CCTV	117	50
Sub-total:	1155	1018

Sub-Zone IV--San Pablo Bay (NOAA Charts 18649, 18654 & 18656)

2 Module 1 radars	620	620
2 Module 10 VHF	38	26
1 Module 11 VHF	48	20
1 Module 13 MET	40	5
Sub-total:	746	671

Port of San Francisco (Cont.)

Sub-Zone V--Carquinez Strait/Suisun Bay (NOAA Chart 18656)

1 Module 1 radar	310	310
1 Module 10 VHF	19	13
1 Module 13 MET	40	5
Sub-total:	369	328

Sub-Zone VI--Sacramento River (NOAA Chart 18661)

3 Module 10 VHF	57	39
1 Module 11 VHF	48	20
Sub-total:	105	59

Sub-Zone VII--Lower San Francisco Bay (NOAA Chart 18650 & 18651)

1 Module 1 radar	310	310
1 Module 10 VHF	19	13
Sub-total:	329	323

Sub-Zone VIII--Redwood Creek (NOAA Chart 18651)

1 Module 10 VHF	19	13
Sub-total:	19	13
HARDWARE TOTALS:	5753	4222
Minus 2 radars	620	
NEW HARDWARE TOTAL:	5133	

Port of San Francisco (Continued)

2.0 PROJECT TOTALS (x $1000)

2.1 Non-recurring

Hardware	$5133
Management, Engineering, etc. (55%) Assumptions: Turnkey system, Procurement by integ.contractor, good manufacturer support, some software provided,System Manual required	2823
Installation site integration (20%) Assumptions: Complete installation by contractor, remote access no serious problem, many widespread sites	1026
Spares & Training (10%)	513
Civil Engineering 9 remote radar sites, many remote comms and WX sensors installations, land acquisition	3000
PROJECT ESTIMATE:	12495
Data Base Management System	300
TOTAL: (non-recurring)	$12795

2.2 Recurring (10 year)

Hardware	4222
2 Watchstanders x 5 = 10 man/years @ 50K x 10	5000
1 Watch Supervisor	2500
1 Commanding Officer	500
1 Executive Officer	500
1 Clerk	500
TOTAL: (recurring) (10-year life)	$13222
TOTAL 10-YEAR PROJECT COST:	$26017

COMMENT:

These costs reflect use of the two existing radars at sites which call for Module 1 radars. Since they are to be moved and re-installed, the engineering installation costs have not been altered. The recurring maintenance costs are the same because the existing radars must also be maintained.

Surveillance Modules -Sub Zones	RADAR						ADS			VHF		MET.		HYD.		DF	CCTV		COMMENTS
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
I																			Required VHF & UHF/DF capacity provided from Sub-ZOne II:Required Radar coverage also from Sub-Zone II
II			1	1									1			1			
III	2	1					25			2		1	1	1				1	
IV	2									2	1		1						
V	1									1			1						
VI										3	1								
VII	1									1									Required Radar Coverage from Sub-Zone III
VIII										1									

SAN FRANCISCO, CA SURVEILLANCE SURVEY

STUDY ZONE INPUT DATA AND OUTPUT STATISTICS

Appendix N Zone 14 San Francisco, CA

TABLE 1 Assignment of COE Waterway Codes to Subzones 8/06/91

COE Waterway		Name
Subzone 1401A		
4200	A	SUISUN BAY CHANNEL, CALIF.
4210	A	SUISUN CHANNEL, CALIF.
4240	A	SACRAMENTO, CALIF.
4260	A	SAN JOAQUIN RIVER, CALIF.
4320	A	SAN FRANCISCO BAY ENTRANCE, CALIF.
4335	A	SAN FRANCISCO HARBOR, CALIF.
4345	A	OAKLAND HARBOR, CALIF.
4346	A	BERKELEY, CALIF.
4355	A	SAN PABLO BAY AND MARE ISLAND STRAIT, CALIF.
4360	A	CARQUINEZ STRAIT, CALIF.
4365	A	NAPA RIVER, CALIF.
4370	A	PETALUMA RIVER, CALIF.
8230	A	SACRAMENTO RIVER DEEPWATER SHIP CHANNEL, CALIF.
Subzone 1402B		
4200	A	SUISUN BAY CHANNEL, CALIF.
4210	A	SUISUN CHANNEL, CALIF.
4240	A	SACRAMENTO, CALIF.
4260	A	SAN JOAQUIN RIVER, CALIF.
4335	A	SAN FRANCISCO HARBOR, CALIF.
4345	A	OAKLAND HARBOR, CALIF.
4346	A	BERKELEY, CALIF.
4355	A	SAN PABLO BAY AND MARE ISLAND STRAIT, CALIF.
4360	A	CARQUINEZ STRAIT, CALIF.
4365	A	NAPA RIVER, CALIF.
4370	A	PETALUMA RIVER, CALIF.
8230	A	SACRAMENTO RIVER DEEPWATER SHIP CHANNEL, CALIF.
Subzone 1403C		
4200	A	SUISUN BAY CHANNEL, CALIF.
4200	B	SUISUN BAY CHANNEL, CALIF.
4210	A	SUISUN CHANNEL, CALIF.
4210	B	SUISUN CHANNEL, CALIF.
4240	A	SACRAMENTO, CALIF.
4240	B	SACRAMENTO, CALIF.
4260	A	SAN JOAQUIN RIVER, CALIF.
4260	B	SAN JOAQUIN RIVER, CALIF.
4335	A	SAN FRANCISCO HARBOR, CALIF.
4335	B	SAN FRANCISCO HARBOR, CALIF.
4345	A	OAKLAND HARBOR, CALIF.
4345	B	OAKLAND HARBOR, CALIF.
4346	A	BERKELEY, CALIF.
4346	B	BERKELEY, CALIF.
4355	A	SAN PABLO BAY AND MARE ISLAND STRAIT, CALIF.
4355	B	SAN PABLO BAY AND MARE ISLAND STRAIT, CALIF.
4360	A	CARQUINEZ STRAIT, CALIF.
4360	B	CARQUINEZ STRAIT, CALIF.
4365	A	NAPA RIVER, CALIF.
4365	B	NAPA RIVER, CALIF.
4370	A	PETALUMA RIVER, CALIF.
4370	B	PETALUMA RIVER, CALIF.
8230	A	SACRAMENTO RIVER DEEPWATER SHIP CHANNEL, CALIF.

TABLE 1   Assignment of COE Waterway Codes to Subzones   8/06/91

COE Waterway		Name
Subzone 1403C		
8230	B	SACRAMENTO RIVER DEEPWATER SHIP CHANNEL, CALIF.
Subzone 1404D		
4345	A	OAKLAND HARBOR, CALIF.
4345	B	OAKLAND HARBOR, CALIF.
Subzone 1405F		
4200	A	SUISUN BAY CHANNEL, CALIF.
4200	B	SUISUN BAY CHANNEL, CALIF.
4210	A	SUISUN CHANNEL, CALIF.
4210	B	SUISUN CHANNEL, CALIF.
4240	A	SACRAMENTO, CALIF.
4240	B	SACRAMENTO, CALIF.
4260	A	SAN JOAQUIN RIVER, CALIF.
4260	B	SAN JOAQUIN RIVER, CALIF.
4360	A	CARQUINEZ STRAIT, CALIF.
4360	B	CARQUINEZ STRAIT, CALIF.
8230	A	SACRAMENTO RIVER DEEPWATER SHIP CHANNEL, CALIF.
8230	B	SACRAMENTO RIVER DEEPWATER SHIP CHANNEL, CALIF.

TABLE 2 Base Year 1987 Cargo Tons by Subzone, Commodity, and Vessel Type

Subzone 1401A

Comm. Code	Name	Dry Cargo	Tanker	Dry Cargo Barge Tow	Tanker Barge Tow	Total
1	FARM PRODUCTS	6,193,355	0	0	0	6,193,355
2	FOREST PRODUCTS	21,366	0	0	0	21,366
3	FISHERIES PRODUCTS	62,592	0	0	0	62,592
4	MINING PRODUCTS, NEC	3,691,871	0	3,021,022	0	6,712,893
5	PROC. FOODS & MFTRS, NEC	28,590,302	0	437,178	0	29,027,480
6	WASTE OF MANUFACTURING	2,590,378	0	4,708,860	0	7,299,238
1311	CRUDE PETROLEUM	0	46,295,094	0	5,280,782	51,575,876
1492	SULPHUR, DRY	2,812,222	0	0	0	2,812,222
2810	SODIUM HYDROXIDE (CAUSTI	158,170	0	0	0	158,170
2811	CRUDE PROD-COAL TAR-PET	7,494	0	0	0	7,494
2813	ALCOHOLS	0	80,431	0	1	80,432
2817	BENZENE AND TOLUENE	0	85,666	0	3	85,669
2871	NITROGEN CHEM FERTILIZER	57,277	1,649,971	0	0	1,707,248
2872	POTASSIC CHEM FERTILIZER	10,921	0	0	0	10,921
2873	PHOSPHA CHEM FERTILIZERS	124	0	0	0	124
2911	GASOLINE, INCL NATURAL	0	9,993,764	0	252,597	10,246,361
2912	JET FUEL	0	1,388,226	0	304,478	1,692,704
2913	KEROSENE	0	44	0	0	44
2914	DISTILLATE FUEL OIL	0	4,341,418	0	779,595	5,121,013
2915	RESIDUAL FUEL OIL	0	18,013,283	0	4,251,694	22,264,977
2916	LUBRIC OILS-GREASES	0	1,605,265	0	91,008	1,696,273
2917	NAPHTHA, PETRLM SOLVENTS	0	488,947	0	148	489,095
2921	LIQUI PETR-COAL-NATR GAS	2	916	0	0	918
	Subzone Total :	44,196,074	83,943,025	8,167,060	10,960,306	147,266,465

Subzone 1402B

Comm. Code	Name	Dry Cargo	Tanker	Dry Cargo Barge Tow	Tanker Barge Tow	Total
1	FARM PRODUCTS	4,492,249	0	0	0	4,492,249
2	FOREST PRODUCTS	10,116	0	0	0	10,116
3	FISHERIES PRODUCTS	31,308	0	0	0	31,308
4	MINING PRODUCTS, NEC	2,460,721	0	3,018,747	0	5,479,468
5	PROC. FOODS & MFTRS, NEC	16,673,534	0	434,903	0	17,108,437
6	WASTE OF MANUFACTURING	1,135,767	0	4,708,860	0	5,844,627
1311	CRUDE PETROLEUM	0	22,658,956	0	5,280,782	27,939,738
1492	SULPHUR, DRY	2,257,060	0	0	0	2,257,060
2810	SODIUM HYDROXIDE (CAUSTI	66,696	0	0	0	66,696
2811	CRUDE PROD-COAL TAR-PET	4,515	0	0	0	4,515
2813	ALCOHOLS	0	33,358	0	1	33,359
2817	BENZENE AND TOLUENE	0	35,366	0	3	35,369
2871	NITROGEN CHEM FERTILIZER	57,277	1,429,053	0	0	1,486,330
2872	POTASSIC CHEM FERTILIZER	5,427	0	0	0	5,427
2873	PHOSPHA CHEM FERTILIZERS	62	0	0	0	62
2911	GASOLINE, INCL NATURAL	0	6,148,244	0	252,597	6,400,841
2912	JET FUEL	0	615,004	0	304,478	919,482
2913	KEROSENE	0	22	0	0	22
2914	DISTILLATE FUEL OIL	0	2,139,281	0	779,595	2,918,876
2915	RESIDUAL FUEL OIL	0	9,481,290	0	4,251,694	13,732,984
2916	LUBRIC OILS-GREASES	0	838,172	0	91,008	929,180
2917	NAPHTHA, PETRLM SOLVENTS	0	259,243	0	148	259,391
2921	LIQUI PETR-COAL-NATR GAS	2	459	0	0	461
	Subzone Total :	27,194,734	43,638,448	8,162,510	10,960,306	89,955,998

TABLE 2 Base Year 1987 Cargo Tons by Subzone, Commodity, and Vessel Type

Subzone 1403C

Comm. Code	Name	Dry Cargo	Tanker	Dry Cargo Barge Tow	Tanker Barge Tow	Total
1	FARM PRODUCTS	4,492,249	0	0	0	4,492,249
2	FOREST PRODUCTS	10,116	0	0	0	10,116
3	FISHERIES PRODUCTS	31,308	0	0	0	31,308
4	MINING PRODUCTS, NEC	2,460,721	0	3,018,747	0	5,479,468
5	PROC. FOODS & MFTRS, NEC	16,673,534	0	434,903	0	17,108,437
6	WASTE OF MANUFACTURING	1,135,767	0	4,708,860	0	5,844,627
1311	CRUDE PETROLEUM	0	22,658,956	0	5,280,782	27,939,738
1492	SULPHUR, DRY	2,257,060	0	0	0	2,257,060
2810	SODIUM HYDROXIDE (CAUSTI	66,696	0	0	0	66,696
2811	CRUDE PROD-COAL TAR-PET	4,515	0	0	0	4,515
2813	ALCOHOLS	0	33,358	0	1	33,359
2817	BENZENE AND TOLUENE	0	35,366	0	3	35,369
2871	NITROGEN CHEM FERTILIZER	57,277	1,429,053	0	0	1,486,330
2872	POTASSIC CHEM FERTILIZER	5,427	0	0	0	5,427
2873	PHOSPHA CHEM FERTILIZERS	62	0	0	0	62
2911	GASOLINE, INCL NATURAL	0	6,148,244	0	252,597	6,400,841
2912	JET FUEL	0	615,004	0	304,478	919,482
2913	KEROSENE	0	22	0	0	22
2914	DISTILLATE FUEL OIL	0	2,139,281	0	779,595	2,918,876
2915	RESIDUAL FUEL OIL	0	9,481,290	0	4,251,694	13,732,984
2916	LUBRIC OILS-GREASES	0	838,172	0	91,008	929,180
2917	NAPHTHA, PETRLM SOLVENTS	0	259,243	0	148	259,391
2921	LIQUI PETR-COAL-NATR GAS	2	459	0	0	461
	Subzone Total :	27,194,734	43,638,448	8,162,510	10,960,306	89,955,998

Subzone 1404D

Comm. Code	Name	Dry Cargo	Tanker	Dry Cargo Barge Tow	Tanker Barge Tow	Total
1	FARM PRODUCTS	733,792	0	0	0	733,792
2	FOREST PRODUCTS	8,035	0	0	0	8,035
3	FISHERIES PRODUCTS	23,845	0	0	0	23,845
4	MINING PRODUCTS, NEC	154,650	0	855,932	0	1,010,582
5	PROC. FOODS & MFTRS, NEC	5,571,799	0	63,202	0	5,635,001
6	WASTE OF MANUFACTURING	849,151	0	77,600	0	926,751
1311	CRUDE PETROLEUM	0	0	0	338	338
1492	SULPHUR, DRY	1,615	0	0	0	1,615
2811	CRUDE PROD-COAL TAR-PET	1,405	0	0	0	1,405
2813	ALCOHOLS	0	4,109	0	1	4,110
2817	BENZENE AND TOLUENE	0	31	0	3	34
2871	NITROGEN CHEM FERTILIZER	51,967	10,212	0	0	62,179
2872	POTASSIC CHEM FERTILIZER	4,986	0	0	0	4,986
2873	PHOSPHA CHEM FERTILIZERS	62	0	0	0	62
2911	GASOLINE, INCL NATURAL	0	1,469	0	6,810	8,279
2912	JET FUEL	0	0	0	19,545	19,545
2914	DISTILLATE FUEL OIL	0	211	0	1,283	1,494
2915	RESIDUAL FUEL OIL	0	0	0	575,025	575,025
2916	LUBRIC OILS-GREASES	0	16,919	0	12,235	29,154
2917	NAPHTHA, PETRLM SOLVENTS	0	462	0	148	610
2921	LIQUI PETR-COAL-NATR GAS	2	457	0	0	459
	Subzone Total :	7,401,309	33,870	996,734	615,388	9,047,301

Appendix N Zone 14 San Francisco, CA 7/15/91

TABLE 2 Base Year 1987 Cargo Tons by Subzone, Commodity, and Vessel Type

Subzone 1405F

Comm. Code	Name	Dry Cargo	Tanker	Dry Cargo Barge Tow	Tanker Barge Tow	Total
1	FARM PRODUCTS	2,792,591	0	0	0	2,792,591
3	FISHERIES PRODUCTS	49	0	0	0	49
4	MINING PRODUCTS, NEC	1,712,580	0	1,116,544	0	2,829,124
5	PROC. FOODS & MFTRS, NEC	6,727,773	0	262,360	0	6,990,133
6	WASTE OF MANUFACTURING	141,114	0	769,160	0	910,274
1311	CRUDE PETROLEUM	0	11,327,010	0	2,165,906	13,492,916
1492	SULPHUR, DRY	1,701,897	0	0	0	1,701,897
2810	SODIUM HYDROXIDE (CAUSTI	49,467	0	0	0	49,467
2811	CRUDE PROD-COAL TAR-PET	1,759	0	0	0	1,759
2813	ALCOHOLS	0	19,973	0	0	19,973
2817	BENZENE AND TOLUENE	0	22,626	0	0	22,626
2871	NITROGEN CHEM FERTILIZER	0	1,157,560	0	0	1,157,560
2911	GASOLINE, INCL NATURAL	0	3,096,834	0	151,216	3,248,050
2912	JET FUEL	0	238,620	0	139,963	378,583
2914	DISTILLATE FUEL OIL	0	587,965	0	450,246	1,038,211
2915	RESIDUAL FUEL OIL	0	4,776,126	0	1,995,695	6,771,821
2916	LUBRIC OILS-GREASES	0	405,737	0	17,994	423,731
2917	NAPHTHA, PETRLM SOLVENTS	0	103,164	0	0	103,164
	Subzone Total :	13,127,230	21,735,615	2,148,064	4,921,020	41,931,929

7/22/91

Appendix N ZONE 14 San Francisco, CA

TABLE 3 Base Year (1987)
Vessel Transits by Subzone, Vessel Type, and Size.

Vessel Type	Large	Medium	Small	Total
Subzone : 1401A				
Passenger	0	60	0	60
Dry Cargo	3,439	7,266	1,149	11,854
Tanker	2,040	2,388	1,008	5,436
Dry Cargo Barge Tow	85	0	358	443
Tanker Barge Tow	156	0	184	340
Tug/Tow Boat	0	0	151	151
Subzone Total:	5,720	9,714	2,850	18,284
Subzone : 1402B				
Passenger	0	60	3,850	3,910
Dry Cargo	1,841	3,629	882	6,352
Tanker	1,141	1,402	804	3,347
Dry Cargo Barge Tow	57	0	0	57
Tanker Barge Tow	120	0	0	120
Subzone Total:	3,159	5,091	5,536	13,786
Subzone : 1403C				
Passenger	0	60	42,107	42,167
Dry Cargo	1,841	3,629	4,412	9,882
Tanker	1,141	1,402	804	3,347
Dry Cargo Barge Tow	57	0	6,746	6,803
Tanker Barge Tow	120	0	3,773	3,893
Tug/Tow Boat	0	0	12,750	12,750
Subzone Total:	3,159	5,091	70,592	78,842
Subzone : 1404D				
Passenger	0	0	100	100
Dry Cargo	1,267	1,504	310	3,081
Tanker	1	0	1	2
Dry Cargo Barge Tow	0	0	697	697
Tanker Barge Tow	0	0	625	625
Tug/Tow Boat	1	C	6,170	6,171
Subzone Total:	1,269	1,504	7,903	10,676

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Appendix N ZONE 14 San Francisco, CA

TABLE 3 Base Year (1987)
Vessel Transits by Subzone, Vessel Type, and Size.

Vessel Type	Large	Medium	Small	Total
Subzone : 1405F				
Dry Cargo	264	1,012	201	1,477
Tanker	571	732	380	1,683
Dry Cargo Barge Tow	56	0	2,889	2,945
Tanker Barge Tow	90	0	1,662	1,752
Tug/Tow Boat	0	0	1,287	1,287
Subzone Total:	981	1,744	6,419	9,144

Note: Sum of all vessel transits within each study subzone.

ZONE TOTALS

ZONE 14 San Francisco, CA

Vessel Type	Large	Medium	Small	Total
Passenger	0	60	42,107	42,167
Dry Cargo	3,439	7,266	4,679	15,384
Tanker	2,040	2,388	1,008	5,436
Dry Cargo Barge Tow	85	0	7,104	7,189
Tanker Barge Tow	156	0	3,957	4,113
Tug/Tow Boat	0	0	12,901	12,901
Zone Total:	5,720	9,714	71,756	87,190

Note: Sum of all arrivals/departures to/from all terminals
within the Study Zone.

Appendix N Zone 14 San Francisco, CA

TABLE 4 Barges Per Tow - Average Factors by COE Waterway 8/6/91

COE Code	Waterway Name	Dry Barge	Tank Barge
SUBZONE	All Subzones within this Zone	1	1

NOTE: Average size of tows arriving/departing terminals within the waterway. Sizes of other tows transiting the area may differ.

Appendix N Zone 14 San Francisco, CA

TABLE 5 Other Local Vessels by Subzone 7/21/91

Subzone	Name	Number of Vessels	Vessels per Square Mile
1401A		7,769	8.77
1402B		5,023	27.91
1403C		68,724	224.59
1404D		20,806	1,434.90
1405F		70,560	801.82
	Total for Zone	172,882	117.25

Note: State registered (1989/90) vessels estimated to be operated within the Subzone.

Appendix N ZONE 14 San Francisco, CA 7/24/91

TABLE 6.1 Forecast 1995
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 1401A				
Passenger	0	63	0	63
Dry Cargo	4,439	9,428	5,868	19,735
Tanker	2,170	2,564	1,064	5,798
Dry Cargo Tow	0	0	8,240	8,240
Tanker Tow	0	0	4,266	4,266
Tug/Tow Boat	0	0	16,242	16,242
Subzone Total:	6,609	12,055	35,680	54,344
Subzone : 1402B				
Passenger	0	63	4,054	4,118
Dry Cargo	2,405	4,712	5,522	12,639
Tanker	1,208	1,503	848	3,559
Dry Cargo Tow	0	0	7,832	7,832
Tanker Tow	0	0	4,057	4,057
Tug/Tow Boat	0	0	16,404	16,404
Subzone Total:	3,613	6,278	38,717	48,609
Subzone : 1403C				
Passenger	0	63	49,680	49,743
Dry Cargo	2,405	4,712	5,522	12,639
Tanker	1,208	1,503	848	3,559
Dry Cargo Tow	0	0	7,832	7,832
Tanker Tow	0	0	4,057	4,057
Tug/Tow Boat	0	0	16,404	16,404
Subzone Total:	3,613	6,278	84,343	94,234
Subzone : 1404D				
Passenger	0	0	4,547	4,547
Dry Cargo	1,681	2,015	412	4,108
Tanker	1	0	0	1
Dry Cargo Tow	0	0	798	798
Tanker Tow	0	0	700	700
Tug/Tow Boat	0	0	8,244	8,244
Subzone Total:	1,682	2,015	14,701	18,398

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Appendix N ZONE 14 San Francisco, CA

TABLE 6.1 Forecast 1995
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 1405F				
Dry Cargo	322	1,238	238	1,798
Tanker	603	786	398	1,787
Dry Cargo Tow	0	0	3,350	3,350
Tanker Tow	0	0	1,785	1,785
Tug/Tow Boat	0	0	1,444	1,444
Subzone Total:	925	2,024	7,215	10,164

Note: Sum of all vessel transits within each study subzone.

Appendix N ZONE 14 San Francisco, CA 7/24/91

TABLE 6.2 Forecast 2000
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 1401A				
Passenger	0	67	0	67
Dry Cargo	5,318	11,056	6,755	23,129
Tanker	2,273	2,727	1,121	6,121
Dry Cargo Tow	0	0	9,036	9,036
Tanker Tow	0	0	4,476	4,476
Tug/Tow Boat	0	0	19,259	19,259
Subzone Total:	7,591	13,850	40,647	62,088
Subzone : 1402B				
Passenger	0	67	4,270	4,336
Dry Cargo	2,901	5,520	6,345	14,766
Tanker	1,262	1,595	893	3,750
Dry Cargo Tow	0	0	8,598	8,598
Tanker Tow	0	0	4,256	4,256
Tug/Tow Boat	0	0	19,403	19,403
Subzone Total:	4,163	7,182	43,765	55,109
Subzone : 1403C				
Passenger	0	67	52,317	52,384
Dry Cargo	2,901	5,520	6,345	14,766
Tanker	1,262	1,595	893	3,750
Dry Cargo Tow	0	0	8,598	8,598
Tanker Tow	0	0	4,256	4,256
Tug/Tow Boat	0	0	19,403	19,403
Subzone Total:	4,163	7,182	91,812	103,157
Subzone : 1404D				
Passenger	0	0	4,789	4,789
Dry Cargo	2,048	2,405	495	4,948
Tanker	1	0	2	3
Dry Cargo Tow	0	0	870	870
Tanker Tow	0	0	752	752
Tug/Tow Boat	0	0	9,942	9,942
Subzone Total:	2,049	2,405	16,850	21,304

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Appendix N ZONE 14 San Francisco, CA

TABLE 6.2 Forecast 2000
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 1405F				
Dry Cargo	371	1,391	264	2,026
Tanker	629	835	417	1,881
Dry Cargo Tow	0	0	3,675	3,675
Tanker Tow	0	0	1,872	1,872
Tug/Tow Boat	0	0	1,561	1,561
Subzone Total:	1,000	2,226	7,789	11,015

Note: Sum of all vessel transits within each study subzone.

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Appendix N ZONE 14 San Francisco, CA

TABLE 6.3 Forecast 2005
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 1401A				
Passenger	0	69	0	69
Dry Cargo	6,443	13,085	7,821	27,349
Tanker	2,378	2,896	1,182	6,456
Dry Cargo Tow	0	0	9,909	9,909
Tanker Tow	0	0	4,701	4,701
Tug/Tow Boat	0	0	23,071	23,071
Subzone Total:	8,821	16,050	46,684	71,555
Subzone : 1402B				
Passenger	0	69	4,419	4,488
Dry Cargo	3,538	6,523	7,332	17,393
Tanker	1,317	1,689	941	3,947
Dry Cargo Tow	0	0	9,441	9,441
Tanker Tow	0	0	4,470	4,470
Tug/Tow Boat	0	0	23,185	23,185
Subzone Total:	4,855	8,281	49,788	62,924
Subzone : 1403C				
Passenger	0	69	54,147	54,216
Dry Cargo	3,538	6,523	7,332	17,393
Tanker	1,317	1,689	941	3,947
Dry Cargo Tow	0	0	9,441	9,441
Tanker Tow	0	0	4,470	4,470
Tug/Tow Boat	0	0	23,185	23,185
Subzone Total:	4,855	8,281	99,516	112,652
Subzone : 1404D				
Passenger	0	0	4,956	4,956
Dry Cargo	2,525	2,898	600	6,023
Tanker	2	0	5	7
Dry Cargo Tow	0	0	949	949
Tanker Tow	0	0	807	807
Tug/Tow Boat	0	0	12,121	12,121
Subzone Total:	2,527	2,898	19,438	24,863

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Appendix N ZONE 14 San Francisco, CA

TABLE 6.3 Forecast 2005
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 1405F				
Dry Cargo	431	1,569	295	2,295
Tanker	655	885	436	1,976
Dry Cargo Tow	0	0	4,031	4,031
Tanker Tow	0	0	1,965	1,965
Tug/Tow Boat	0	0	1,695	1,695
Subzone Total:	1,086	2,454	8,422	11,962

Note: Sum of all vessel transits within each study subzone.

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Appendix N ZONE 14 San Francisco, CA

TABLE 6.4 Forecast 2010
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 1401A				
Passenger	0	71	0	71
Dry Cargo	7,892	15,640	9,124	32,656
Tanker	2,468	3,069	1,239	6,776
Dry Cargo Tow	0	0	10,866	10,866
Tanker Tow	0	0	4,940	4,940
Tug/Tow Boat	0	0	27,938	27,938
Subzone Total:	10,360	18,780	54,107	83,247
Subzone : 1402B				
Passenger	0	71	4,574	4,645
Dry Cargo	4,360	7,778	8,535	20,673
Tanker	1,361	1,786	986	4,133
Dry Cargo Tow	0	0	10,368	10,368
Tanker Tow	0	0	4,700	4,700
Tug/Tow Boat	0	0	28,005	28,005
Subzone Total:	5,721	9,635	57,168	72,524
Subzone : 1403C				
Passenger	0	71	56,041	56,113
Dry Cargo	4,360	7,778	8,535	20,673
Tanker	1,361	1,786	986	4,133
Dry Cargo Tow	0	0	10,368	10,368
Tanker Tow	0	0	4,700	4,700
Tug/Tow Boat	0	0	28,005	28,005
Subzone Total:	5,721	9,635	108,635	123,992
Subzone : 1404D				
Passenger	0	0	5,130	5,130
Dry Cargo	3,149	3,529	734	7,412
Tanker	2	0	9	11
Dry Cargo Tow	0	0	1,035	1,035
Tanker Tow	0	0	867	867
Tug/Tow Boat	0	0	14,945	14,945
Subzone Total:	3,151	3,529	22,720	29,400

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Appendix N ZONE 14 San Francisco, CA

TABLE 6.4 Forecast 2010
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 1405F				
Dry Cargo	501	1,778	330	2,609
Tanker	676	937	453	2,066
Dry Cargo Tow	0	0	4,423	4,423
Tanker Tow	0	0	2,065	2,065
Tug/Tow Boat	0	0	1,842	1,842
Subzone Total:	1,177	2,715	9,113	13,005

Note: Sum of all vessel transits within each study subzone.

Appendix N ZONE 14 San Francisco, CA

TABLE 6.5 Forecast 1995 - 2010 Vessel Transits by Vessel Type and Size

Vessel Type	Large	Medium	Small	Total
	1995 FORECASTED ZONE TOTALS			
Passenger	0	63	44,343	44,406
Dry Cargo	4,049	8,622	5,485	18,156
Tanker	2,170	2,564	1,064	5,798
Dry Cargo Tow	0	0	8,240	8,240
Tanker Tow	0	0	4,266	4,266
Tug/Tow Boat	0	0	16,242	16,242
1995 Zone Total:	6,219	11,249	79,640	97,108
	2000 FORECASTED ZONE TOTALS			
Passenger	0	67	46,697	46,763
Dry Cargo	4,584	9,569	6,034	20,187
Tanker	2,273	2,727	1,121	6,121
Dry Cargo Tow	0	0	9,036	9,036
Tanker Tow	0	0	4,476	4,476
Tug/Tow Boat	0	0	19,259	19,259
2000 Zone Total:	6,857	12,363	86,623	105,842
	2005 FORECASTED ZONE TOTALS			
Passenger	0	69	48,330	48,399
Dry Cargo	5,554	11,003	6,791	23,348
Tanker	2,378	2,896	1,182	6,456
Dry Cargo Tow	0	0	9,909	9,909
Tanker Tow	0	0	4,701	4,701
Tug/Tow Boat	0	0	23,071	23,071
2005 Zone Total:	7,932	13,968	93,984	115,884
	2010 FORECASTED ZONE TOTALS			
Passenger	0	71	50,021	50,092
Dry Cargo	6,803	13,145	7,871	27,819
Tanker	2,468	3,069	1,239	6,776
Dry Cargo Tow	0	0	10,866	10,866
Tanker Tow	0	0	4,940	4,940
Tug/Tow Boat	0	0	27,938	27,938
2010 Zone Total:	9,271	16,285	102,875	128,431

Note: Sum of all arrivals/departures to/from all terminals within the study zone.

TABLE 7 Vessel Casualty History (10 Year Totals) by Subzone, Vessel Type and Size, and Casualty Type

Vessel Type	Size	Collisions	Rammings	Groundings	Other	Total
Subzone: 1402B						
Dry Cargo	Large	1	0	0	0	1
Tanker	Large	1	0	0	0	1
Dry Cargo Barge Tow	Small	0	1	0	0	1
Fishing	Small	2	0	0	0	2
Subzone Totals:		4	1	0	0	5
Subzone: 1403C						
Dry Cargo	Large	0	0	1	0	1
Dry Cargo	Small	2	0	0	0	2
Tanker	Large	0	2	0	0	2
Dry Cargo Barge Tow	Large	1	0	0	0	1
Dry Cargo Barge Tow	Small	1	0	0	0	1
Tanker Barge Tow	Small	1	0	0	0	1
Tug/Tow Boat	Small	2	1	0	0	3
Other	Small	1	1	0	0	2
Subzone Totals:		8	4	1	0	13
Subzone: 1404D						
Dry Cargo	Large	1	0	0	0	1
Dry Cargo Barge Tow	Small	1	0	0	0	1
Subzone Totals:		2	0	0	0	2
Subzone: 1405F						
Dry Cargo	Large	0	0	4	0	4
Dry Cargo	Medium	0	1	0	0	1
Tanker	Large	0	0	1	0	1
Tanker Barge Tow	Small	0	1	1	0	2
Tug/Tow Boat	Small	0	1	0	0	1
Subzone Totals:		0	3	6	0	9
Zone Totals:		14	8	7	0	29

Note: OTHER equals barge breakaways and weather caused vessel casualties.

APPENDIX TABLE N-8 ZONE 14, SAN FRANCISCO, CA - VTS LEVELS IN OPERATION

19	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95-2010
SUBZONE																	
1401A																	III
1402B	II	II	II	II	II	II	II	II	II	II	II	II					III
1403C	II	II	II	II	II	II	II	II	II	II	II	II					III
1404D	II	II	II	II	II	II	II	II	II	II	II	II					III
1405F																	I

LEGEND

VTS Level I -

A Vessel Movement Reporting System consisting of VHF radio communications and various vessel reporting waypoints. No radar surveillance is included.

VTS Level II -

The Vessel Movement Reporting System of Level I is coupled with basic radar surveillance. The radar technology is assumed to be equivalent to a good quality, recent vintage, standard shipboard radar without any advanced features.

VTS Level III -

This level represents the new Coast Guard state-of-the-art Candidate VTS Design defined for each study zone.

APPENDIX TABLE N-9 ZONE 14, SAN FRANCISCO, CA
CANDIDATE VTS DESIGN - 1995-2010

UNITS

5	Radar Module 1	- Average Performance
1	Radar Module 2	- Average Performance
1	Radar Module 3	- High Performance
1	Radar Module 4	- High Performance
0	Radar Module 5	- Special Purpose
0	Radar Module 6	- Special Purpose
25	ADS Module 7	- Active Radar Transponder (Type 1)
0	ADS Module 8	- Positional Transponder, Small Area, Very High Accuracy (Type 5)
0	ADS Module 9	- Positional Transponder, Small Area, High Accuracy (Type 6)
10	VHF Module 10	- Low power VHF Transmitting/ Receiving Facility
4	VHF Module 11	- High power VHF Transmitting/ Receiving Facility
1	Meteorological Module 12	- Air temperature, wind direction and speed
4	Meteorological Module 13	- Air temperature, wind direction and speed, visibility
1	Hydrological Module 14	- Water Temperature and Depth
0	Hydrological Module 15	- Water Temperature, Depth and Current
1	VHF/DF MODULE 16	- Line of position measurement to 2 degree RMS
0	CCTV MODULE 17	- Fixed Focus CCTV via Telephone Lines
1	CCTV MODULE 18	- Remotely Controllable CCTV via

TABLE 10A

Avoided Vessel Casualties 1996 - 2010
Candidate VTS Systems

7/31/91

Counts

Vessel Type	Size	Collision	Ramming	Grounding	Total
Passenger	Medium	.06	0.00	.10	.15
Passenger	Small	.58	.10	.87	1.55
Dry Cargo	Large	1.61	.32	2.65	4.58
Dry Cargo	Medium	1.18	.23	.63	2.04
Dry Cargo	Small	.24	.03	.06	.33
Tanker	Large	1.43	.42	2.61	4.47
Tanker	Medium	.23	.03	.18	.44
Tanker	Small	.05	0.00	.05	.10
Dry Cargo Barge T	Small	2.17	.87	1.07	4.12
Tanker Barge Tow	Small	1.21	.28	.98	2.46
Tug/Tow Boat	Small	.60	.23	.59	1.43
		9.36	2.51	9.80	21.66

Undiscounted Total Dollar Losses (1,000)

Vessel Type	Size	Collision	Ramming	Grounding	Total
Passenger	Medium	107	0	107	214
Passenger	Small	530	91	555	1,176
Dry Cargo	Large	2,351	589	855	3,795
Dry Cargo	Medium	1,864	452	193	2,510
Dry Cargo	Small	171	23	39	233
Tanker	Large	6,285	1,962	6,583	14,831
Tanker	Medium	336	47	92	475
Tanker	Small	33	0	15	48
Dry Cargo Barge T	Small	122	132	17	271
Tanker Barge Tow	Small	4,271	998	608	5,876
Tug/Tow Boat	Small	50	36	47	133
		16,121	4,331	9,110	29,562

Note: In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 10B Avoided Vessel Casualties 1996 - 2010 7/31/91
Existing VTS Systems

Counts

Vessel Type	Size	Collision	Ramming	Grounding	Total
Passenger	Medium	.04	0.00	.07	.11
Passenger	Small	.45	.10	.75	1.30
Dry Cargo	Large	1.01	.23	1.88	3.12
Dry Cargo	Medium	.68	.15	.42	1.25
Dry Cargo	Small	.17	.03	.05	.25
Tanker	Large	.71	.23	1.61	2.55
Tanker	Medium	.11	.01	.11	.24
Tanker	Small	.03	0.00	.04	.06
Dry Cargo Barge T	Small	1.25	.54	.82	2.61
Tanker Barge Tow	Small	.71	.17	.75	1.62
Tug/Tow Boat	Small	.46	.21	.52	1.19
		5.62	1.67	7.01	14.31

Undiscounted Total Dollar Losses (1,000)

Vessel Type	Size	Collision	Ramming	Grounding	Total
Passenger	Medium	73	0	80	153
Passenger	Small	407	87	483	978
Dry Cargo	Large	1,483	430	608	2,521
Dry Cargo	Medium	1,078	296	129	1,504
Dry Cargo	Small	123	21	32	176
Tanker	Large	3,133	1,069	4,037	8,240
Tanker	Medium	168	25	57	250
Tanker	Small	18	0	10	29
Dry Cargo Barge T	Small	70	79	13	163
Tanker Barge Tow	Small	2,518	627	467	3,612
Tug/Tow Boat	Small	39	34	41	113
		9,111	2,669	5,958	17,738

Note: In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 11   Avoided Fatalities 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Medium	.01	0.00	.01	.02
Passenger	Small	.04	.01	.06	.10
Dry Cargo	Large	20	.04	.33	.57
Dry Cargo	Medium	.15	.03	.08	.26
Dry Cargo	Small	.02	.00	.00	.02
Tanker	Small	.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	.00	.00	.00	.01
Tanker Barge Tow	Small	.00	.00	.00	.01
Tug/Tow Boat	Small	.00	.00	.00	.00
Totals		.42	.08	.49	.99
Candidate VTS Design - Dollars					
Passenger	Medium	11,072.49	0.00	17,926.83	28,999.32
Passenger	Small	55,702.08	9,639.92	83,189.82	148,531.83
Dry Cargo	Large	302,574.70	59,638.16	498,764.09	860,976.96
Dry Cargo	Medium	222,535.61	43,032.35	118,240.97	383,808.94
Dry Cargo	Small	22,676.91	3,022.56	5,796.76	31,496.22
Tanker	Small	161.04	0.00	169.73	330.77
Dry Cargo Barge Tow	Small	7,189.41	2,886.26	3,548.50	13,624.18
Tanker Barge Tow	Small	3,991.47	912.20	3,232.24	8,135.91
Tug/Tow Boat	Small	1,993.50	756.32	1,961.74	4,711.56
Totals		627,897.21	119,887.78	732,830.69	1,480,615.68
Existing VTS Design - Counts					
Passenger	Medium	.01	0.00	.01	.01
Passenger	Small	.03	.01	.05	.08
Dry Cargo	Large	.13	.03	.24	.39
Dry Cargo	Medium	.09	.02	.05	.16
Dry Cargo	Small	.01	.00	.00	.02
Tanker	Small	.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	.00	.00	.00	.01
Tanker Barge Tow	Small	.00	.00	.00	.00
Tug/Tow Boat	Small	.00	.00	.00	.00
Totals		.26	.06	.35	.67
Existing VTS Design - Dollars					
Passenger	Medium	7,668.94	0.00	13,731.83	21,400.78
Passenger	Small	42,768.10	9,253.90	72,416.27	124,438.28
Dry Cargo	Large	190,577.38	43,334.77	353,478.47	587,390.62
Dry Cargo	Medium	128,427.95	28,058.02	78,834.74	235,320.71
Dry Cargo	Small	16,302.26	2,659.68	4,799.72	23,761.66
Tanker	Small	88.40	0.00	119.17	207.58
Dry Cargo Barge Tow	Small	4,143.79	1,771.19	2,704.92	8,619.90
Tanker Barge Tow	Small	2,334.71	566.29	2,470.69	5,371.69
Tug/Tow Boat	Small	1,524.96	707.67	1,703.44	3,936.07
Totals		393,836.50	86,351.52	530,259.27	1,010,447.29

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 12 Avoided Human Injuries 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Medium	.00	0.00	.00	.00
Passenger	Small	.44	.08	.66	1.17
Dry Cargo	Large	.02	.00	.04	.06
Dry Cargo	Medium	.02	.00	.01	.03
Dry Cargo	Small	.18	.02	.05	.25
Tanker	Small	.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	.05	.02	.03	.10
Tanker Barge Tow	Small	.03	.01	.02	.06
Tug/Tow Boat	Small	.01	.01	.01	.03
Totals		.76	.14	.81	1.71
Candidate VTS Design - Dollars					
Passenger	Medium	190.11	0.00	307.80	497.91
Passenger	Small	104,887.94	18,152.14	156,647.82	279,687.90
Dry Cargo	Large	5,195.13	1,023.97	8,563.65	14,782.75
Dry Cargo	Medium	3,820.88	738.85	2,030.17	6,589.90
Dry Cargo	Small	42,700.99	5,691.52	10,915.39	59,307.91
Tanker	Small	281.38	0.00	296.57	577.95
Dry Cargo Barge Tow	Small	12,562.16	5,043.21	6,200.35	23,805.72
Tanker Barge Tow	Small	6,974.36	1,593.90	5,647.73	14,215.99
Tug/Tow Boat	Small	3,483.27	1,321.53	3,427.78	8,232.58
Totals		180,096.23	33,565.13	194,037.26	407,698.61
Existing VTS Design - Counts					
Passenger	Medium	.00	0.00	.00	.00
Passenger	Small	.34	.07	.57	.98
Dry Cargo	Large	.01	.00	.03	.04
Dry Cargo	Medium	.01	.00	.01	.02
Dry Cargo	Small	.13	.02	.04	.19
Tanker	Small	.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	.03	.01	.02	.06
Tanker Barge Tow	Small	.02	.00	.02	.04
Tug/Tow Boat	Small	.01	.01	.01	.03
Totals		.55	.12	.69	1.37
Existing VTS Design - Dollars					
Passenger	Medium	131.67	0.00	235.77	367.45
Passenger	Small	80,533.05	17,425.26	136,361.05	234,319.35
Dry Cargo	Large	3,272.16	744.05	6,069.13	10,085.34
Dry Cargo	Medium	2,205.07	481.75	1,353.57	4,040.40
Dry Cargo	Small	30,697.42	5,008.22	9,037.96	44,743.60
Tanker	Small	154.47	0.00	208.24	362.70
Dry Cargo Barge Tow	Small	7,240.51	3,094.83	4,726.34	15,061.68
Tanker Barge Tow	Small	4,079.47	989.49	4,317.08	9,386.04
Tug/Tow Boat	Small	2,664.59	1,236.52	2,976.45	6,877.56
Totals		130,978.41	28,980.12	165,285.58	325,244.11

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 13 Avoided Vessels Damaged 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Medium	.04	0.00	.04	.08
Passenger	Small	.49	.07	.27	.83
Dry Cargo	Large	1.19	.22	.26	1.68
Dry Cargo	Medium	.88	.16	.06	1.10
Dry Cargo	Small	.20	.02	.03	.26
Tanker	Large	1.08	.34	.34	1.76
Tanker	Medium	.17	.02	.02	.22
Tanker	Small	.01	0.00	.01	.02
Dry Cargo Barge Tow	Small	1.66	.37	.15	2.18
Tanker Barge Tow	Small	.92	.12	.14	1.17
Tug/Tow Boat	Small	.11	.03	.07	.21
Totals		6.76	1.35	1.40	9.51
Candidate VTS Design - Dollars					
Passenger	Medium	38,092.18	0.00	35,809.75	73,901.93
Passenger	Small	168,520.00	22,795.34	139,454.51	330,769.85
Dry Cargo	Large	879,450.94	165,887.51	153,594.07	1,198,932.51
Dry Cargo	Medium	781,417.53	144,606.94	27,223.57	953,248.04
Dry Cargo	Small	38,419.03	4,163.89	8,118.29	50,701.21
Tanker	Large	848,811.01	266,932.39	738,044.99	1,853,788.38
Tanker	Medium	114,182.06	14,611.06	43,372.34	172,165.46
Tanker	Small	3,191.43	0.00	4,387.58	7,579.01
Dry Cargo Barge Tow	Small	96,356.17	21,419.72	7,593.49	125,369.39
Tanker Barge Tow	Small	65,356.53	8,270.64	12,288.07	85,915.25
Tug/Tow Boat	Small	7,606.30	1,853.50	7,278.38	16,738.18
Totals		3,041,403.18	650,540.99	1,177,165.05	4,869,109.22
Existing VTS Design - Counts					
Passenger	Medium	.03	0.00	.03	.06
Passenger	Small	.38	.06	.24	.68
Dry Cargo	Large	.75	.16	.18	1.10
Dry Cargo	Medium	.51	.11	.04	.65
Dry Cargo	Small	.15	.02	.03	.19
Tanker	Large	.54	.18	.21	.93
Tanker	Medium	.09	.01	.01	.11
Tanker	Small	.01	0.00	.01	.01
Dry Cargo Barge Tow	Small	.96	.23	.11	1.30
Tanker Barge Tow	Small	.54	.07	.10	.72
Tug/Tow Boat	Small	.08	.02	.06	.17
Totals		4.02	.87	1.03	5.93
Existing VTS Design - Dollars					
Passenger	Medium	26,383.10	0.00	27,430.04	53,813.14
Passenger	Small	129,389.79	21,882.53	121,394.37	272,666.69
Dry Cargo	Large	553,924.24	120,538.53	108,853.46	783,316.22
Dry Cargo	Medium	450,965.35	94,286.82	18,150.76	563,402.93
Dry Cargo	Small	27,619.15	3,663.99	6,721.96	38,005.10
Tanker	Large	422,807.24	145,174.25	454,238.40	1,022,219.89
Tanker	Medium	56,574.09	7,876.67	26,701.26	91,152.02
Tanker	Small	1,751.99	0.00	3,080.68	4,832.67
Dry Cargo Barge Tow	Small	55,537.25	13,144.51	5,788.28	74,470.04
Tanker Barge Tow	Small	38,228.57	5,134.38	9,392.90	52,755.85
Tug/Tow Boat	Small	5,818.56	1,734.28	6,320.06	13,872.90
Totals		1,768,999.33	413,435.96	788,072.17	2,970,507.45

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 14 Avoided Cargo Damage/Loss 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Medium	.01	0.00	.01	.02
Passenger	Small	.12	.02	.08	.21
Dry Cargo	Large	.43	.11	.24	.78
Dry Cargo	Medium	.32	.08	.06	.45
Dry Cargo	Small	.08	.01	.01	.10
Tanker	Large	.39	.12	.25	.76
Tanker	Medium	.06	.01	.02	.09
Tanker	Small	.01	0.00	.01	.02
Dry Cargo Tow	Small	.31	.12	.06	.49
Tanker Tow	Small	.17	.04	.06	.26
Tug/Tow Boat	Small	.04	.01	.02	.08
Totals		1.93	.52	.81	3.25
Candidate VTS Design - Dollars					
Passenger	Medium	167.58	0.00	111.45	279.03
Passenger	Small	426.17	57.65	314.94	798.76
Dry Cargo	Large	4,527.88	1,264.41	705.80	6,498.09
Dry Cargo	Medium	3,330.13	912.34	167.32	4,409.80
Dry Cargo	Small	174.36	18.90	36.44	229.70
Tanker	Large	18,654.81	5,569.02	26,713.09	50,936.92
Tanker	Medium	799.83	101.13	179.19	1,080.15
Tanker	Small	38.42	0.00	25.71	64.13
Tanker Tow	Small	13,293.61	3,043.50	4,365.10	20,702.21
Tug/Tow Boat	Small	91.56	22.31	85.28	199.15
Totals		41,504.36	10,989.26	32,704.33	85,197.95
Existing VTS Design - Counts					
Passenger	Medium	.01	0.00	.01	.01
Passenger	Small	.09	.02	.07	.18
Dry Cargo	Large	.27	.08	.17	.52
Dry Cargo	Medium	.18	.05	.04	.27
Dry Cargo	Small	.05	.01	.01	.07
Tanker	Large	.19	.06	.16	.41
Tanker	Medium	.03	.00	.01	.05
Tanker	Small	.00	0.00	.00	.01
Dry Cargo Tow	Small	.18	.08	.05	.30
Tanker Tow	Small	.10	.02	.04	.17
Tug/Tow Boat	Small	.03	.01	.02	.06
Totals		1.14	.34	.57	2.05
Existing VTS Design - Dollars					
Passenger	Medium	116.07	0.00	85.37	201.44
Passenger	Small	327.22	55.34	274.15	656.71
Dry Cargo	Large	2,851.90	918.76	500.21	4,270.86
Dry Cargo	Medium	1,921.86	594.87	111.56	2,628.29
Dry Cargo	Small	125.34	16.63	30.17	172.15
Tanker	Large	10,220.37	3,351.82	18,208.11	31,780.30
Tanker	Medium	405.96	55.88	118.44	580.28
Tanker	Small	22.89	0.00	19.01	41.90
Tanker Tow	Small	8,567.65	2,075.88	3,683.92	14,327.45
Tug/Tow Boat	Small	70.04	20.88	74.05	164.97
Totals		24,629.30	7,090.05	23,104.99	54,824.34

Note1: Dollar values include bulk petroleum and chemical cargos only and all vessel fuels spilled. Dollar values exclude cargo loss/damage for non-tank vessel types.

Note2: In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 15 Avoided NavAid Damage 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Small	0.00	.01	.00	.02
Dry Cargo	Large	0.00	.04	.02	.05
Dry Cargo	Medium	0.00	.03	.00	.03
Dry Cargo	Small	0.00	.00	.00	.00
Tanker	Large	0.00	.05	.01	.06
Tanker	Medium	0.00	.00	.00	.00
Tanker	Small	0.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	0.00	.10	.01	.11
Tanker Barge Tow	Small	0.00	.03	.01	.04
Tug/Tow Boat	Small	0.00	.03	.00	.03
Totals		0.00	.29	.06	.34
Candidate VTS Design - Dollars					
Passenger	Small	0.00	64.81	28.00	92.81
Dry Cargo	Large	0.00	204.66	85.69	290.35
Dry Cargo	Medium	0.00	147.68	20.31	167.99
Dry Cargo	Small	0.00	20.32	1.95	22.27
Tanker	Large	0.00	274.03	84.47	358.51
Tanker	Medium	0.00	17.81	5.95	23.76
Tanker	Small	0.00	0.00	1.66	1.66
Dry Cargo Barge Tow	Small	0.00	563.64	34.69	598.34
Tanker Barge Tow	Small	0.00	178.14	31.60	209.74
Tug/Tow Boat	Small	0.00	147.70	19.18	166.88
Totals		0.00	1,618.80	313.50	1,932.30
Existing VTS Design - Counts					
Passenger	Small	0.00	.01	.00	.02
Dry Cargo	Large	0.00	.03	.01	.04
Dry Cargo	Medium	0.00	.02	.00	.02
Dry Cargo	Small	0.00	.00	.00	.00
Tanker	Large	0.00	.03	.01	.04
Tanker	Medium	0.00	.00	.00	.00
Tanker	Small	0.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	0.00	.06	.00	.07
Tanker Barge Tow	Small	0.00	.02	.00	.02
Tug/Tow Boat	Small	0.00	.02	.00	.03
Totals		0.00	.19	.04	.23
Existing VTS Design - Dollars					
Passenger	Small	0.00	62.21	24.37	86.59
Dry Cargo	Large	0.00	148.71	60.73	209.44
Dry Cargo	Medium	0.00	96.29	13.54	109.83
Dry Cargo	Small	0.00	17.88	1.62	19.50
Tanker	Large	0.00	149.04	51.99	201.03
Tanker	Medium	0.00	9.60	3.66	13.27
Tanker	Small	0.00	0.00	1.17	1.17
Dry Cargo Barge Tow	Small	0.00	345.89	26.44	372.33
Tanker Barge Tow	Small	0.00	110.59	24.15	134.74
Tug/Tow Boat	Small	0.00	138.20	16.65	154.85
Totals		0.00	1,078.41	224.33	1,302.74

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 16 Avoided Bridge Damage 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Small	.00	.01	0.00	.01
Dry Cargo	Large	0.00	.02	0.00	.02
Dry Cargo	Medium	0.00	.01	0.00	.01
Dry Cargo	Small	.00	.00	0.00	.00
Tanker	Large	0.00	.03	0.00	.03
Tanker	Medium	0.00	.00	0.00	.00
Tanker	Small	.00	0.00	0.00	.00
Dry Cargo Barge Tow	Small	.00	.05	0.00	.05
Tanker Barge Tow	Small	.00	.02	0.00	.02
Tug/Tow Boat	Small	.00	.01	0.00	.01
Totals		.01	.15	0.00	.16
Candidate VTS Design - Dollars					
Passenger	Small	1,536.37	11,958.26	0.00	13,494.63
Dry Cargo	Large	0.00	37,427.49	0.00	37,427.49
Dry Cargo	Medium	0.00	29,922.07	0.00	29,922.07
Dry Cargo	Small	550.71	3,334.29	0.00	3,884.99
Tanker	Large	0.00	66,776.68	0.00	66,776.68
Tanker	Medium	0.00	4,398.95	0.00	4,398.95
Tanker	Small	88.30	0.00	0.00	88.30
Dry Cargo Barge Tow	Small	5,524.84	102,294.59	0.00	107,819.43
Tanker Barge Tow	Small	2,887.46	30,952.02	0.00	33,839.48
Tug/Tow Boat	Small	1,266.87	22,592.09	0.00	23,858.97
Totals		11,854.55	309,656.45	0.00	321,510.99
Existing VTS Design - Counts					
Passenger	Small	.00	.01	0.00	.01
Dry Cargo	Large	0.00	.01	0.00	.01
Dry Cargo	Medium	0.00	.01	0.00	.01
Dry Cargo	Small	.00	.00	0.00	.00
Tanker	Large	0.00	.02	0.00	.02
Tanker	Medium	0.00	.00	0.00	.00
Tanker	Small	.00	0.00	0.00	.00
Dry Cargo Barge Tow	Small	.00	.03	0.00	.03
Tanker Barge Tow	Small	.00	.01	0.00	.01
Tug/Tow Boat	Small	.00	.01	0.00	.01
Totals		.00	.10	0.00	.10
Existing VTS Design - Dollars					
Passenger	Small	1,179.58	11,479.93	0.00	12,659.52
Dry Cargo	Large	0.00	28,821.10	0.00	28,821.10
Dry Cargo	Medium	0.00	20,017.99	0.00	20,017.99
Dry Cargo	Small	408.47	3,026.04	0.00	3,434.50
Tanker	Large	0.00	35,181.47	0.00	35,181.47
Tanker	Medium	0.00	2,267.83	0.00	2,267.83
Tanker	Small	48.40	0.00	0.00	48.40
Dry Cargo Barge Tow	Small	3,099.67	61,139.05	0.00	64,238.72
Tanker Barge Tow	Small	1,607.26	18,296.22	0.00	19,903.48
Tug/Tow Boat	Small	959.87	21,222.73	0.00	22,182.60
Totals		7,303.26	201,452.36	0.00	208,755.62

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

Appendix N Zone 14 San Francisco, CA
TABLE 17 Avoided Hazardous Commodity Spills 1996 - 2010 7/30/91

Commodity	Catastrophic	Large	Medium	Small	Total
Candidate Vts Design - Counts					
ALCOHOLS	0.00	.00	.00	.00	.00
BENZENE AND TOLUENE	0.00	.00	.00	.00	.00
KEROSENE	.00	.00	.00	.00	.00
JET FUEL	.00	.00	.01	.00	.01
DISTILLATE FUEL OIL	.00	.01	.02	.30	.33
GASOLINE, INCL NATURAL	.01	.01	.04	.00	.06
RESIDUAL FUEL OIL	.01	.05	.49	.89	1.43
CRUDE PETROLEUM	.02	.05	.06	.01	.13
	.04	.12	.61	1.20	1.97
Existing Vts Design - Counts					
ALCOHOLS	0.00	.00	.00	.00	.00
BENZENE AND TOLUENE	0.00	.00	.00	.00	.00
KEROSENE	.00	.00	.00	.00	.00
JET FUEL	.00	.00	.00	.00	.01
DISTILLATE FUEL OIL	.00	.00	.01	.24	.26
GASOLINE, INCL NATURAL	.00	.01	.02	.00	.03
RESIDUAL FUEL OIL	.01	.03	.29	.52	.85
CRUDE PETROLEUM	.01	.03	.03	.00	.07
	.02	.07	.36	.77	1.23

Note: In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

Appendix N Zone 14 San Francisco, CA
TABLE 18A Annual Benefit & Cost Streams 7/31/91
Candidate VTS Systems

Discounted to 1993

Year	Investment ($1,000)	Operation & Maintenance ($1,000)	Benefits ($1,000)
1993	13,917	0	0
1996	0	1,041	1,423
1997	0	946	1,307
1998	0	860	1,201
1999	0	782	1,104
2000	0	711	1,015
2001	0	646	935
2002	0	587	861
2003	0	534	793
2004	0	485	730
2005	0	441	673
2006	0	401	620
2007	0	365	572
2008	0	332	527
2009	0	301	486
2010	0	274	448
	13,917	8,707	12,694

Undiscounted

Year	Investment ($1,000)	Operation & Maintenance ($1,000)	Benefits ($1,000)
1993	13,917	0	0
1996	0	1,322	1,807
1997	0	1,322	1,827
1998	0	1,322	1,847
1999	0	1,322	1,867
2000	0	1,322	1,887
2001	0	1,322	1,912
2002	0	1,322	1,938
2003	0	1,322	1,964
2004	0	1,322	1,989
2005	0	1,322	2,015
2006	0	1,322	2,044
2007	0	1,322	2,073
2008	0	1,322	2,101
2009	0	1,322	2,130
2010	0	1,322	2,160
	13,917	19,833	29,562

Appendix N Zone 14 San Francisco, CA
TABLE 18B Annual Benefit & Cost Streams 7/31/91
Existing VTS Systems

Discounted to 1993

Year	Investment ($1,000)	Operation & Maintenance ($1,000)	Benefits ($1,000)
1993	0	0	0
1996	0	1,771	849
1997	0	1,610	781
1998	0	1,464	718
1999	0	1,331	660
2000	0	1,210	607
2001	0	1,100	560
2002	0	1,000	516
2003	0	909	476
2004	0	826	438
2005	0	751	404
2006	0	683	373
2007	0	621	344
2008	0	564	317
2009	0	513	293
2010	0	466	270
	0	14,817	7,607

Undiscounted

Year	Investment ($1,000)	Operation & Maintenance ($1,000)	Benefits ($1,000)
1993	0	0	0
1996	0	2,250	1,079
1997	0	2,250	1,092
1998	0	2,250	1,104
1999	0	2,250	1,117
2000	0	2,250	1,129
2001	0	2,250	1,145
2002	0	2,250	1,161
2003	0	2,250	1,178
2004	0	2,250	1,194
2005	0	2,250	1,210
2006	0	2,250	1,229
2007	0	2,250	1,247
2008	0	2,250	1,266
2009	0	2,250	1,285
2010	0	2,250	1,303
	0	33,750	17,738

APPENDIX N

ZONE 14 - SAN FRANCISCO, CA

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

San Franscico Port & Subzone	Species Category	(Port 14) Species Code	Species Name	Wildlife Abundance Tables Fish & Shellfish Grams per Square Meter Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
1401	101	1	American Shad	.0458	.0458	.0458	.0458
1401	101	81	Chinook Salmon	.0167	.0167	.0167	.0167
1401	101	82	Coho Salmon	.0130	.0130	.0130	0.0000
1401	102	44	Stripped Mullet	.0024	.0024	.0024	.0024
1401	102	83	Pacific Mackerel	.4800	.4800	.4800	.4800
1401	102	84	Jack Mackerel	.0318	.0318	.0318	.0318
1401	102	85	Pacific Anchovy	1.1900	1.1900	1.1900	1.1900
1401	102	86	Pacific Herring	.8341	.8341	.8341	.8341
1401	103	50	Bonito	.0750	.1500	.0750	0.0000
1401	104	12	Tuna	0.0000	.2200	0.0000	0.0000
1401	104	13	Swordfish	.0480	.0480	.0480	.0480
1401	104	14	Sapfin Shark	.0160	.0160	.0160	.0160
1401	104	14	Shark	.0178	.0178	.0178	.0178
1401	104	15	Spiny Dogfish	.8460	.8460	.8460	.8460
1401	105	88	Halibut	.0270	.0270	.0270	.0270
1401	105	104	Starry Flounder	.0157	.0157	.0157	.0157
1401	105	106	Dover Sole	.2528	.2528	.2528	.2528
1401	105	107	English Sole	.3716	.3716	.3716	.3716
1401	105	108	Rock Sole	.0013	.0013	.0013	.0013
1401	105	117	Spotted Ratfish	.0256	.0256	.0256	.0256
1401	105	140	Slendersole	.0057	.0057	.0057	.0057
1401	105	242	Petrale Sole	.0374	.0374	.0374	.0374
1401	105	250	Rex Sole	.1829	.1829	.1829	.1829
1401	106	76	Seabass	.0070	.0070	.0070	.0070
1401	106	90	Bocaccio	.1046	.1046	.1046	.1046
1401	106	90	Cannery Rockfish	.8718	.8718	.8718	.8718
1401	106	90	Chilepeper	.8034	.8034	.8034	.8034
1401	106	90	Copper Rockfish	.0133	.0133	.0133	.0133
1401	106	90	Dark Blocted Rockfish	.0352	.0352	.0352	.0352
1401	106	90	Greenstripe Rockfish	.0501	.0501	.0501	.0501
1401	106	90	Splitnose Rockfish	.1203	.1203	.1203	.1203
1401	106	90	Stripetail Rockfish	.2947	.2947	.2947	.2947
1401	106	90	Widow Rockfish	.0335	.0335	.0335	.0335
1401	106	90	Yellowtail Rockfish	.1853	.1853	.1853	.1853
1401	106	92	Sablefish	.1721	.1721	.1721	.1721
1401	106	94	Lingcod	.1692	.1692	.1692	.1692
1401	106	95	Pacific Whiting	2.0457	2.0457	2.0457	2.0457
1401	106	112	Pacific Sanddab	.2896	.2896	.2896	.2896
1401	106	116	Big Skate	.0151	.0151	.0151	.0151
1401	106	116	Longnose Skate	.0607	.0607	.0607	.0607
1401	106	135	Plainfin Midshipmen	.1186	.1186	.1186	.1186
1401	106	199	Pacific Pompano	.0307	.0307	.0307	.0307
1401	106	253	White Croaker	.2942	.2942	.2942	.2942
1401	108	217	Crabs	.0850	.0850	.0850	.0580
1401	108	219	Spiny Lobster	.0300	.0300	.0300	.0300
1401	108	221	Dungness Crab	.0035	.0035	.0035	.0035
1401	108	222	Shrimp	.2700	.2700	.2700	.2700
1401	109	223	Market Squid	.0101	.0101	.0101	.0101
1401	109	223	Squid	.4800	.4800	.4800	.4800
1402	101	1	American Shad	.0458	.0458	.0458	.0458
1402	101	81	Chinook Salmon	.0167	.0167	.0167	.0167
1402	101	82	Coho Salmon	.0130	.0130	.0130	0.0000

APPENDIX N

ZONE 14 - SAN FRANCISCO, CA (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

San Franscico Port & Subzone	Species Category	(Port 14) Species Code	Species Name	Wildlife Abundance Tables Fish & Shellfish Grams per Square Meter Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
1402	102	44	Striped Mullet	.0024	.0024	.0024	.0024
1402	102	83	Pacific Mackerel	.4800	.4800	.4800	.4800
1402	102	84	Jack Mackerel	.0318	.0318	.0318	.0318
1402	102	85	Pacific Anchovy	1.1900	1.1900	1.1900	1.1900
1402	102	86	Pacific Herring	.8341	.8341	.8341	.8341
1402	103	50	Bonito	.0750	.1500	.0750	0.0000
1402	104	12	Tuna	0.0000	.2200	0.0000	0.0000
1402	104	13	Swordfish	.0480	.0480	.0480	.0480
1402	104	14	Sapfin Shark	.0160	.0160	.0160	.0160
1402	104	14	Shark	.0178	.0178	.0178	.0178
1402	104	15	Spiny Dogfish	.8460	.8460	.8460	.8460
1402	105	88	Halibut	.0270	.0270	.0270	.0270
1402	105	104	Starry Flounder	.0157	.0157	.0157	.0157
1402	105	106	Dover Sole	.2528	.2528	.2528	.2528
1402	105	107	English Sole	.3716	.3716	.3716	.3716
1402	105	108	Rock Sole	.0013	.0013	.0013	.0013
1402	105	117	Spotted Ratfish	.0256	.0256	.0256	.0256
1402	105	140	Slendersole	.0057	.0057	.0057	.0057
1402	105	242	Petrale Sole	.0374	.0374	.0374	.0374
1402	105	250	Rex Sole	.1829	.1829	.1829	.1829
1402	106	76	Seabass	.0070	.0070	.0070	.0070
1402	106	90	Bocaccio	.1046	.1046	.1046	.1046
1402	106	90	Cannery Rockfish	.8718	.8718	.8718	.8718
1402	106	90	Chilepeper	.8034	.8034	.8034	.8034
1402	106	90	Copper Rockfish	.0133	.0133	.0133	.0133
1402	106	90	Dark Blocted Rockfish	.0352	.0352	.0352	.0352
1402	106	90	Greenstripe Rockfish	.0501	.0501	.0501	.0501
1402	106	90	Splitnose Rockfish	.1203	.1203	.1203	.1203
1402	106	90	Stripetail Rockfish	.2947	.2947	.2947	.2947
1402	106	90	Widow Rockfish	.0335	.0335	.0335	.0335
1402	106	90	Yellowtail Rockfish	.1853	.1853	.1853	.1853
1402	106	92	Sablefish	.1721	.1721	.1721	.1721
1402	106	94	Lingcod	.1692	.1692	.1692	.1692
1402	106	95	Pacific Whiting	2.0457	2.0457	2.0457	2.0457
1402	106	112	Pacific Sanddab	.2896	.2896	.2896	.2896
1402	106	116	Big Skate	.0151	.0151	.0151	.0151
1402	106	116	Longnose Skate	.0607	.0607	.0607	.0607
1402	106	135	Plainfin Midshipmen	.1186	.1186	.1186	.1186
1402	106	199	Pacific Pompano	.0307	.0307	.0307	.0307
1402	106	253	White Croaker	.2942	.2942	.2942	.2942
1402	108	217	Crabs	.0850	.0850	.0850	.0580
1402	108	219	Spiny Lobster	.0300	.0300	.0300	.0300
1402	108	221	Dungness Crab	.0035	.0035	.0035	.0035
1402	108	222	Shrimp	.2700	.2700	.2700	.2700
1402	109	223	Market Squid	.0101	.0101	.0101	.0101
1402	109	223	Squid	.4800	.4800	.4800	.4800
1403	101	1	American Shad	9.6139	8.9435	39.0094	11.4039
1403	101	81	King Salmon	6.8800	1.9700	7.0490	18.1570
1403	101	262	Threadfin Shad	.0062	.0923	.8949	.0062
1403	102	85	Anchovy	.7700	.7700	.3800	.7700
1403	102	86	Pacific Herring	26.1500	11.2300	6.2500	25.8900
1403	102	126	Sunfish	.0123	0.0000	0.0000	.0393
1403	102	256	Three Spine Stickleback	.0984	.0049	0.0000	1.0112
1403	102	263	Northern Anchovy	7.5800	15.0000	1.6300	1.4500

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

San Franscico		(Port 14)		Wildlife Abundance Tables Fish & Shellfish Grams per Square Meter			
Port & Subzone	Species Category	Species Code	Species Name	Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
1403	103	9	Stripped Bass	39.1693	8.5436	10.9610	10.5817
1403	103	264	Steelhead Rainbow Trout	1.7468	.3199	.0738	.2952
1403	104	14	Shark	1.7000	1.7000	1.7000	1.7000
1403	105	104	Starry Flounder	4.8346	1.3286	.3875	.2706
1403	105	137	Sand Sole	.0184	0.0000	0.0000	.0369
1403	106	48	Catfish	0.0000	.0553	0.0000	.1107
1403	106	90	Rockfish	.0307	0.0000	0.0000	.0307
1403	106	91	Shiner Perch	.5289	.0246	.0184	.0492
1403	106	91	Walleye Surfperch	.0615	.0369	0.0000	.0123
1403	106	94	Lingcod	.1107	0.0000	0.0000	0.0000
1403	106	103	Smelt	.3494	4.5900	.5019	.1658
1403	106	103	Smelt	50.3660	2.2346	.1845	17.5942
1403	106	109	Sculpin	.6200	.6815	.0074	.1181
1403	106	115	Pacific Tomcod	.2398	0.0000	.1107	1.9375
1403	106	120	Gobies	.1594	0.0000	0.0000	.1420
1403	106	199	Northern Midshipmen	.9349	.4428	.0147	.0098
1403	106	199	Pacific Lamprey	.1107	0.0000	0.0000	.1661
1403	106	199	River Lamprey	.1599	0.0000	0.0000	.1107
1403	106	199	Splittail	1.2449	0.0000	0.0000	.6938
1403	106	244	Bay Pipefish	.2017	.0074	.0074	.0541
1403	106	253	White Croaker	.0934	0.0000	.0024	.2500
1403	106	265	Carp	.0639	0.0000	0.0000	.0196
1403	107	211	Dungeness Crab	.4700	.4700	.4700	.4700
1403	108	222	Pacific Shrimp	2.4000	2.4000	2.4000	2.4000
1404	101	1	American Shad	9.6139	8.9435	39.0094	11.4039
1404	101	81	King Salmon	6.8800	1.9700	7.0490	18.1570
1404	101	262	Threadfin Shad	.0062	.0923	.8949	.0062
1404	102	85	Anchovy	.7700	.7700	.3800	.7700
1404	102	86	Pacific Herring	26.1500	11.2300	6.2500	25.8900
1404	102	126	Sunfish	.0123	0.0000	0.0000	.0393
1404	102	256	Three Spine Stickleback	.0984	.0049	0.0000	1.0112
1404	102	263	Northern Anchovy	7.5800	15.0000	1.6300	1.4500
1404	103	9	Striped Bass	39.1693	8.5436	10.9610	10.5817
1404	103	264	Steelhead Rainbow Trout	1.7468	.3199	.0738	.2952
1404	104	14	Shark	1.7000	1.7000	1.7000	1.7000
1404	105	104	Starry Flounder	4.8346	1.3286	.3875	.2706
1404	105	137	Sand Sole	.0184	0.0000	0.0000	.0369
1404	106	48	Catfish	0.0000	.0553	0.0000	.1107
1404	106	90	Rockfish	.0307	0.0000	0.0000	.0307
1404	106	91	Shiner Perch	.5289	.0246	.0184	.0492
1404	106	91	Walleye Surfperch	.0615	.0369	0.0000	.0123
1404	106	94	Lingcod	.1107	0.0000	0.0000	0.0000
1404	106	103	Smelt	.3494	4.5900	.5019	.1658
1404	106	103	Smelt	50.3660	2.2346	.1845	17.5942
1404	106	109	Sculpin	.6200	.6815	.0074	.1181
1404	106	115	Pacific Tomcod	.2398	0.0000	.1107	1.9375
1404	106	120	Gobies	.1594	0.0000	0.0000	.1420
1404	106	199	Northern Midshipmen	.9349	.4428	.0147	.0098
1404	106	199	Pacific Lamprey	.1107	0.0000	0.0000	.1661
1404	106	199	River Lamprey	.1599	0.0000	0.0000	.1107
1404	106	199	Splittail	1.2449	0.0000	0.0000	.6938
1404	106	244	Bay Pipefish	.2017	.0074	.0074	.0541
1404	106	253	White Croaker	.0934	0.0000	.0024	.2500

APPENDIX N

ZONE 14 - SAN FRANCISCO, CA (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

San Franscico (Port 14) Port & Subzone	Species Category	Species Code	Species Name	Wildlife Abundance Tables Fish & Shellfish Grams per Square Meter Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
1404	106	265	Carp	.0639	0.0000	0.0000	.0196
1404	107	211	Dungeness Crab	.4700	.4700	.4700	.4700
1404	108	222	Pacific Shrimp	2.4000	2.4000	2.4000	2.4000
1405	101	1	American Shad	9.6139	8.9435	39.0094	11.4039
1405	101	81	King Salmon	6.8800	1.9700	7.0490	18.1570
1405	101	262	Threadfin Shad	.0062	.0923	.8949	.0062
1405	102	85	Anchovy	.7700	.7700	.3800	.7700
1405	102	86	Pacific Herring	26.1500	11.2300	6.2500	25.8900
1405	102	126	Sunfish	.0123	0.0000	0.0000	.0393
1405	102	256	Three Spine Stickleback	.0984	.0049	0.0000	1.0112
1405	102	263	Northern Anchovy	7.5800	15.0000	1.6300	1.4500
1405	103	9	Stripped Bass	39.1693	8.5436	10.9610	10.5817
1405	103	264	Steelhead Rainbow Trout	1.7468	.3199	.0738	.2952
1405	104	14	Shark	1.7000	1.7000	1.7000	1.7000
1405	105	104	Starry Flounder	4.8346	1.3286	.3875	.2706
1405	105	137	Sand Sole	.0184	0.0000	0.0000	.0369
1405	106	48	Catfish	0.0000	.0553	0.0000	.1107
1405	106	90	Rockfish	.0307	0.0000	0.0000	.0307
1405	106	91	Shiner Perch	.5289	.0246	.0184	.0492
1405	106	91	Walleye Surfperch	.0615	.0369	0.0000	.0123
1405	106	94	Lingcod	.1107	0.0000	0.0000	0.0000
1405	106	103	Smelt	.3494	4.5900	.5019	.1658
1405	106	103	Smelt	50.3660	2.2346	.1845	17.5942
1405	106	109	Sculpin	.6200	.6815	.0074	.1181
1405	106	115	Pacific Tomcod	.2398	0.0000	.1107	1.9375
1405	106	120	Gobies	.1594	0.0000	0.0000	.1420
1405	106	199	Northern Midshipmen	.9349	.4428	.0147	.0098
1405	106	199	Pacific Lamprey	.1107	0.0000	0.0000	.1661
1405	106	199	River Lamprey	.1599	0.0000	0.0000	.1107
1405	106	199	Splittail	1.2449	0.0000	0.0000	.6938
1405	106	244	Bay Pipefish	.2017	.0074	.0074	.0541
1405	106	253	White Croaker	.0934	0.0000	.0024	.2500
1405	106	265	Carp	.0639	0.0000	0.0000	.0196
1405	107	211	Dungeness Crab	.4700	.4700	.4700	.4700
1405	108	222	Pacific Shrimp	2.4000	2.4000	2.4000	2.4000

APPENDIX N

ZONEZONE-1SAN SRANERSSOJSCO,(Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

San Franscico Port & Subzone	Species Category	(Port 14) Species Code	Species Name	Wildlife Abundance Tables Fish & Shellfish Larvae Numbers per Square Meter Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
1401	202	1084	Jack Mackerel	.0100	.2500	0.0000	.0500
1401	202	1084	Jack Mackerel	.0100	.2500	0.0000	.0500
1401	202	1263	Northern Anchovy	25.0000	5.0000	2.0000	0.0000
1401	202	1263	Northern Anchovy	25.0000	5.0000	2.0000	0.0000
1401	203	1199	Larvae	2.1000	2.0000	.1000	0.0000
1401	203	1199	Larvae	2.1000	2.0000	.1000	0.0000
1401	204	1199	Larvae	2.1000	0.0000	0.0000	0.0000
1401	204	1199	Larvae	2.1000	0.0000	0.0000	0.0000
1401	205	1088	California Halibut	.2500	0.0000	0.0000	0.0000
1401	205	1088	California Halibut	.2500	0.0000	0.0000	0.0000
1401	205	1100	Dover Sole	5.0000	.2500	0.0000	0.0000
1401	205	1100	Dover Sole	5.0000	.2500	0.0000	0.0000
1401	205	1101	Turbots	0.0000	0.0000	.2500	0.0000
1401	205	1101	Turbots	0.0000	0.0000	.2500	0.0000
1401	205	1107	English Sole	.1000	0.0000	0.0000	.2500
1401	205	1107	English Sole	.1000	0.0000	0.0000	.2500
1401	205	1113	Other Sanddabs	5.0000	0.0000	.5000	.0100
1401	205	1113	Other Sanddabs	5.0000	0.0000	.5000	.0100
1401	205	1139	Speckled Sanddab	2.5000	0.0000	5.0000	0.0000
1401	205	1139	Speckled Sanddab	2.5000	0.0000	5.0000	0.0000
1401	205	1140	Slender Sole	.5000	.2500	0.0000	0.0000
1401	205	1140	Slender Sole	.5000	.2500	0.0000	0.0000
1401	205	1242	Rex Sole	.5000	.2500	0.0000	0.0000
1401	205	1242	Rex Sole	.5000	.2500	0.0000	0.0000
1401	206	1090	Rockfishes	6.9500	1.6300	3.7630	23.1100
1401	206	1090	Rockfishes	6.9500	1.6300	3.7630	23.1100
1401	206	1095	Pacific Hake	.2500	0.0000	0.0000	.2500
1401	206	1095	Pacific Hake	.2500	0.0000	0.0000	.2500
1401	207	1199	Larvae	2.0000	20.0000	2.0000	0.0000
1401	207	1199	Larvae	2.0000	20.0000	2.0000	0.0000
1401	208	1199	Larvae	.0016	.0042	0.0000	0.0000
1401	208	1199	Larvae	.0016	.0042	0.0000	0.0000
1402	202	1084	Jack Mackerel	.0100	.2500	0.0000	.0500
1402	202	1084	Jack Mackerel	.0100	.2500	0.0000	.0500
1402	202	1263	Northern Anchovy	25.0000	5.0000	2.0000	0.0000
1402	202	1263	Northern Anchovy	25.0000	5.0000	2.0000	0.0000
1402	203	1199	Larvae	2.1000	2.0000	.1000	0.0000
1402	203	1199	Larvae	2.1000	2.0000	.1000	0.0000
1402	204	1199	Larvae	2.1000	0.0000	0.0000	0.0000
1402	204	1199	Larvae	2.1000	0.0000	0.0000	0.0000
1402	205	1088	California Halibut	.2500	0.0000	0.0000	0.0000
1402	205	1088	California Halibut	.2500	0.0000	0.0000	0.0000
1402	205	1100	Dover Sole	5.0000	.2500	0.0000	0.0000
1402	205	1100	Dover Sole	5.0000	.2500	0.0000	0.0000
1402	205	1101	Turbots	0.0000	0.0000	.2500	0.0000
1402	205	1101	Turbots	0.0000	0.0000	.2500	0.0000
1402	205	1107	English Sole	.1000	0.0000	0.0000	.2500
1402	205	1107	English Sole	.1000	0.0000	0.0000	.2500
1402	205	1113	Other Sanddabs	5.0000	0.0000	.5000	.0100
1402	205	1113	Other Sanddabs	5.0000	0.0000	.5000	.0100
1402	205	1139	Speckled Sanddab	2.5000	0.0000	5.0000	0.0000
1402	205	1139	Speckled Sanddab	2.5000	0.0000	5.0000	0.0000
1402	205	1140	Slender Sole	.5000	.2500	0.0000	0.0000
1402	205	1140	Slender Sole	.5000	.2500	0.0000	0.0000

APPENDIX N

ZONE 14 - SAN FRANCISCO, CA (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

San Franscico Port & Subzone	Species Category	(Port 14) Species Code	Species Name	Wildlife Abundance Tables Fish & Shellfish Larvae Numbers per Square Meter Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
1402	205	1242	Rex Sole	.5000	.2500	0.0000	0.0000
1402	205	1242	Rex Sole	.5000	.2500	0.0000	0.0000
1402	206	1090	Rockfishes	6.9500	1.6300	3.7630	23.1100
1402	206	1090	Rockfishes	6.9500	1.6300	3.7630	23.1100
1402	206	1095	Pacific Hake	.2500	0.0000	0.0000	.2500
1402	206	1095	Pacific Hake	.2500	0.0000	0.0000	.2500
1402	207	1199	Larvae	2.0000	20.0000	2.0000	0.0000
1402	207	1199	Larvae	2.0000	20.0000	2.0000	0.0000
1402	208	1199	Larvae	.0016	.0042	0.0000	0.0000
1402	208	1199	Larvae	.0016	.0042	0.0000	0.0000
1403	202	1199	Larvae	1367.0000	651.0000	65.0000	1367.0000
1403	203	1199	Larvae	12.2000	11.6000	.5800	0.0000
1403	205	1199	Larvae	5.0000	5.8000	.5800	5.8000
1403	206	1199	Larvae	15.4000	23.1000	7.7000	15.4000
1403	207	1199	Larvae	20.0000	200.0000	20.0000	0.0000
1403	208	1199	Larvae	.0160	.0420	0.0000	0.0000
1404	202	1199	Larvae	1367.0000	651.0000	65.0000	1367.0000
1404	203	1199	Larvae	12.2000	11.6000	.5800	0.0000
1404	205	1199	Larvae	5.0000	5.8000	.5800	5.8000
1404	206	1199	Larvae	15.4000	23.1000	7.7000	15.4000
1404	207	1199	Larvae	20.0000	200.0000	20.0000	0.0000
1404	208	1199	Larvae	.0160	.0420	0.0000	0.0000
1405	202	1199	Larvae	1367.0000	651.0000	65.0000	1367.0000
1405	203	1199	Larvae	12.2000	11.6000	.5800	0.0000
1405	205	1199	Larvae	5.0000	5.8000	.5800	5.8000
1405	206	1199	Larvae	15.4000	23.1000	7.7000	15.4000
1405	207	1199	Larvae	20.0000	200.0000	20.0000	0.0000
1405	208	1199	Larvae	.0160	.0420	0.0000	0.0000

ZONE 14 - SAN FRANCISCO, CA (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

San Franscico		(Port 14)		Wildlife Abundance Tables Birds Numbers per Square Kilometer			
Port & Subzone	Species Category	Species Code	Species Name	Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
1401	111	511	Ducks	115.0000	0.0000	115.0000	0.0000
1401	111	512	Coots	3.3000	0.0000	3.3000	6.5000
1401	111	513	Geese	18.0000	0.0000	18.0000	36.0000
1401	111	514	Swans	1.7000	0.0000	1.7000	3.3000
1401	111	515	Scoters	6.3500	6.3500	6.3500	6.3500
1401	111	516	Loons	2.6500	2.6500	2.6500	2.6500
1401	111	517	Grebes	.8000	.8000	.8000	.8000
1401	112	570	Shorebirds	582.0000	405.0000	588.0000	729.0000
1401	113	530	Cormorants	.4700	.4700	.4700	.4700
1401	113	531	Gulls	88.9200	88.9200	88.9200	88.9200
1401	113	534	Sheerwater	.9800	.9800	.9800	.9800
1401	113	535	Jaegers	.0600	.0600	.0600	.0600
1401	113	541	Alcids	39.4500	39.4500	39.4500	39.4500
1401	113	542	Phalaropes	1.0500	1.0500	1.0500	1.0500
1401	113	546	Pelicans	.1800	.1800	.1800	.1800
1401	113	599	Other Birds	1.3800	1.3800	1.3800	1.3800
1402	111	511	Ducks	115.0000	0.0000	115.0000	0.0000
1402	111	512	Coots	3.3000	0.0000	3.3000	6.5000
1402	111	513	Geese	18.0000	0.0000	18.0000	36.0000
1402	111	514	Swans	1.7000	0.0000	1.7000	3.3000
1402	111	515	Scoters	6.3500	6.3500	6.3500	6.3500
1402	111	516	Loons	2.6500	2.6500	2.6500	2.6500
1402	111	517	Grebes	.8000	.8000	.8000	.8000
1402	112	570	Shorebirds	582.0000	405.0000	588.0000	729.0000
1402	113	530	Cormorants	.4700	.4700	.4700	.4700
1402	113	531	Gulls	88.9200	88.9200	88.9200	88.9200
1402	113	534	Sheerwater	.9800	.9800	.9800	.9800
1402	113	535	Jaegers	.0600	.0600	.0600	.0600
1402	113	541	Alcids	39.4500	39.4500	39.4500	39.4500
1402	113	542	Phalaropes	1.0500	1.0500	1.0500	1.0500
1402	113	546	Pelicans	.1800	.1800	.1800	.1800
1402	113	599	Other Birds	1.3800	1.3800	1.3800	1.3800
1403	111	511	Ducks	115.0000	0.0000	115.0000	0.0000
1403	111	512	Coots	3.3000	0.0000	3.3000	6.5000
1403	111	513	Geese	18.0000	0.0000	18.0000	36.0000
1403	111	514	Swans	1.7000	0.0000	1.7000	3.3000
1403	112	570	Shorebirds	582.0000	405.0000	588.0000	729.0000
1403	113	530	Seabirds	32.3000	32.3000	32.3000	32.3000
1404	111	511	Ducks	115.0000	0.0000	115.0000	0.0000
1404	111	512	Coots	3.3000	0.0000	3.3000	6.5000
1404	111	513	Geese	18.0000	0.0000	18.0000	36.0000
1404	111	514	Swans	1.7000	0.0000	1.7000	3.3000
1404	112	570	Shorebirds	582.0000	405.0000	588.0000	729.0000
1404	113	530	Seabirds	32.3000	32.3000	32.3000	32.3000
1405	111	511	Ducks	115.0000	0.0000	115.0000	0.0000
1405	111	512	Coots	3.3000	0.0000	3.3000	6.5000
1405	111	513	Geese	18.0000	0.0000	18.0000	36.0000
1405	111	514	Swans	1.7000	0.0000	1.7000	3.3000
1405	112	570	Shorebirds	582.0000	405.0000	588.0000	729.0000
1405	113	530	Seabirds	32.3000	32.3000	32.3000	32.3000

APPENDIX O

PORTLAND, OR

(ZONE 15)

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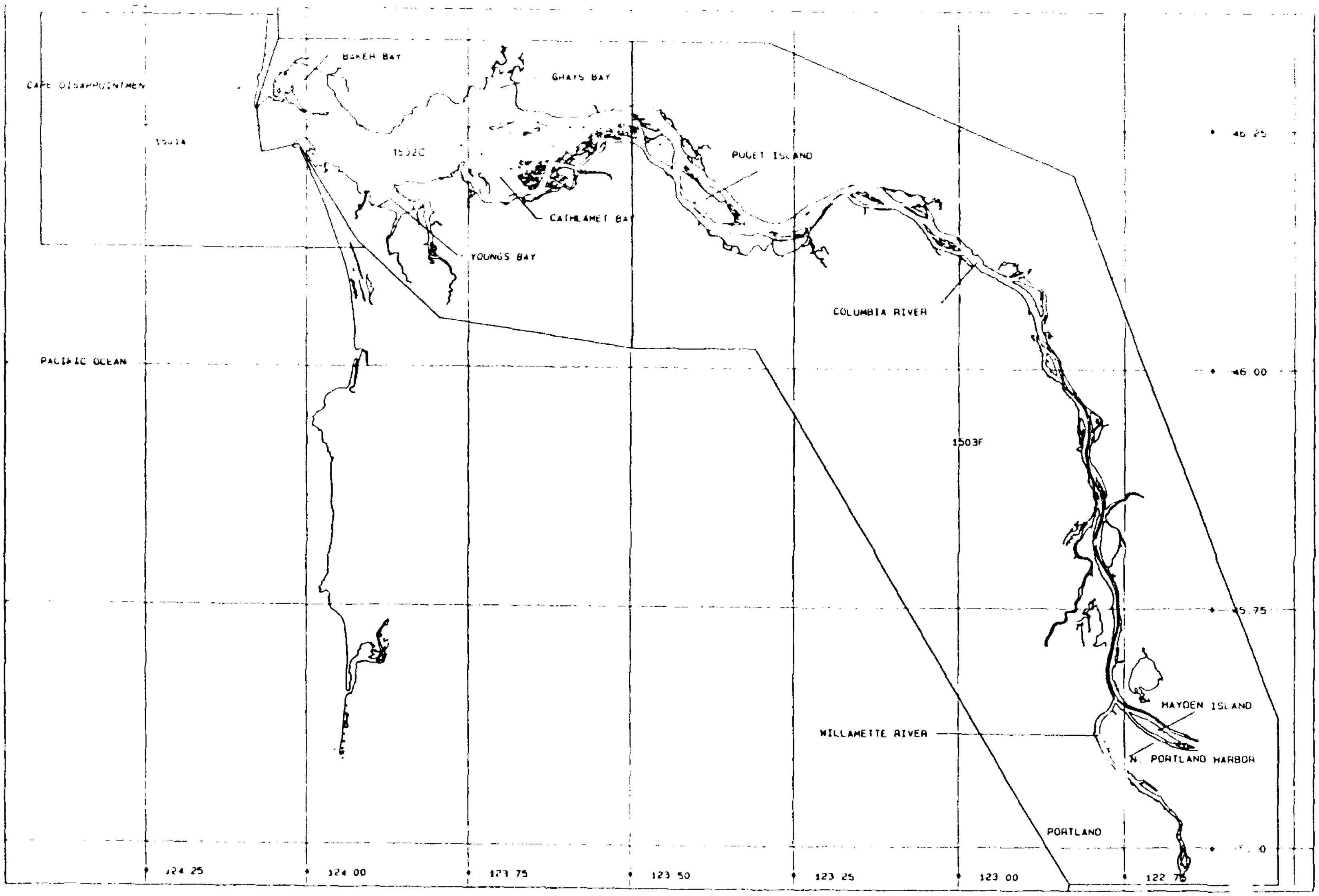
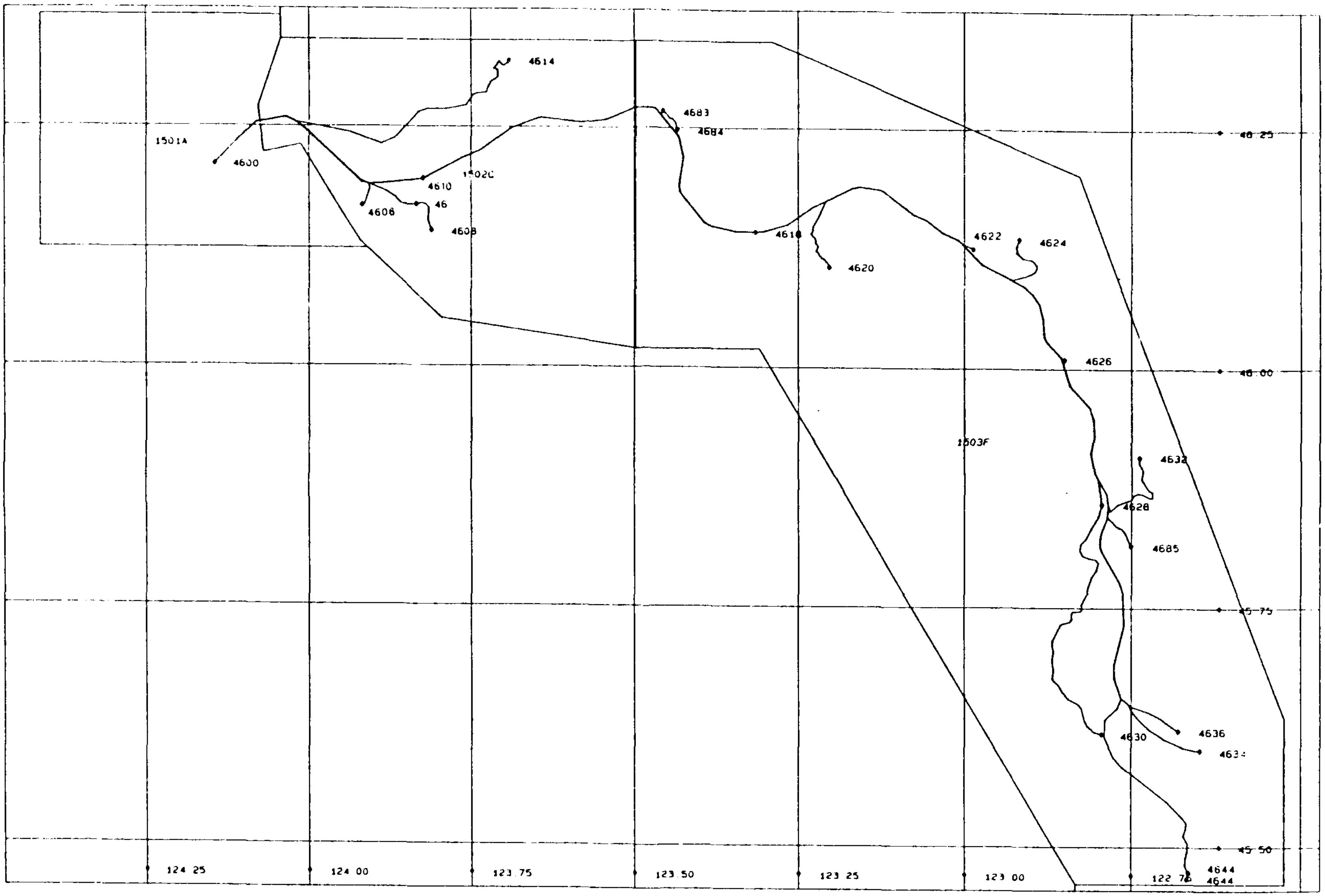
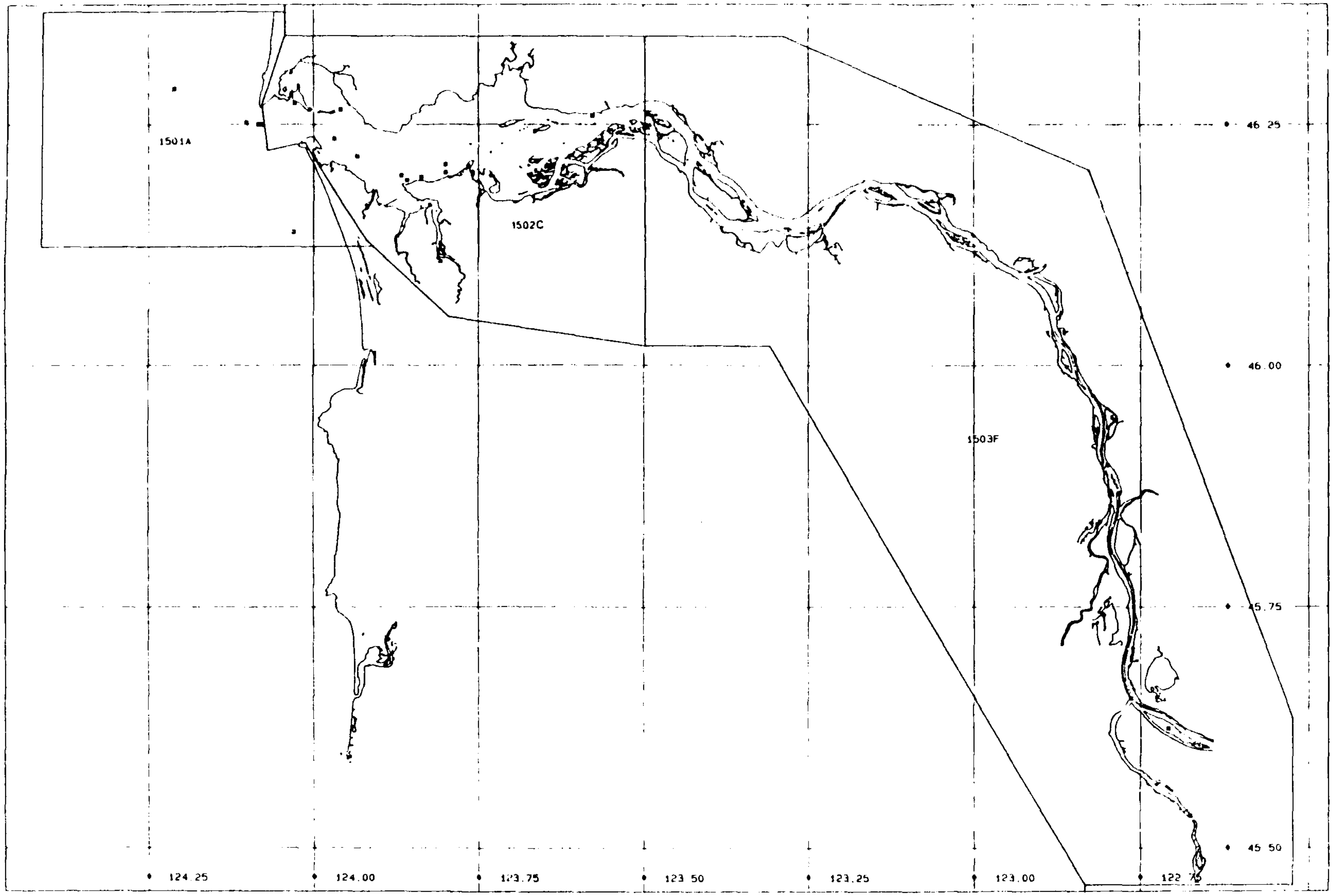
STUDY ZONE MAPS



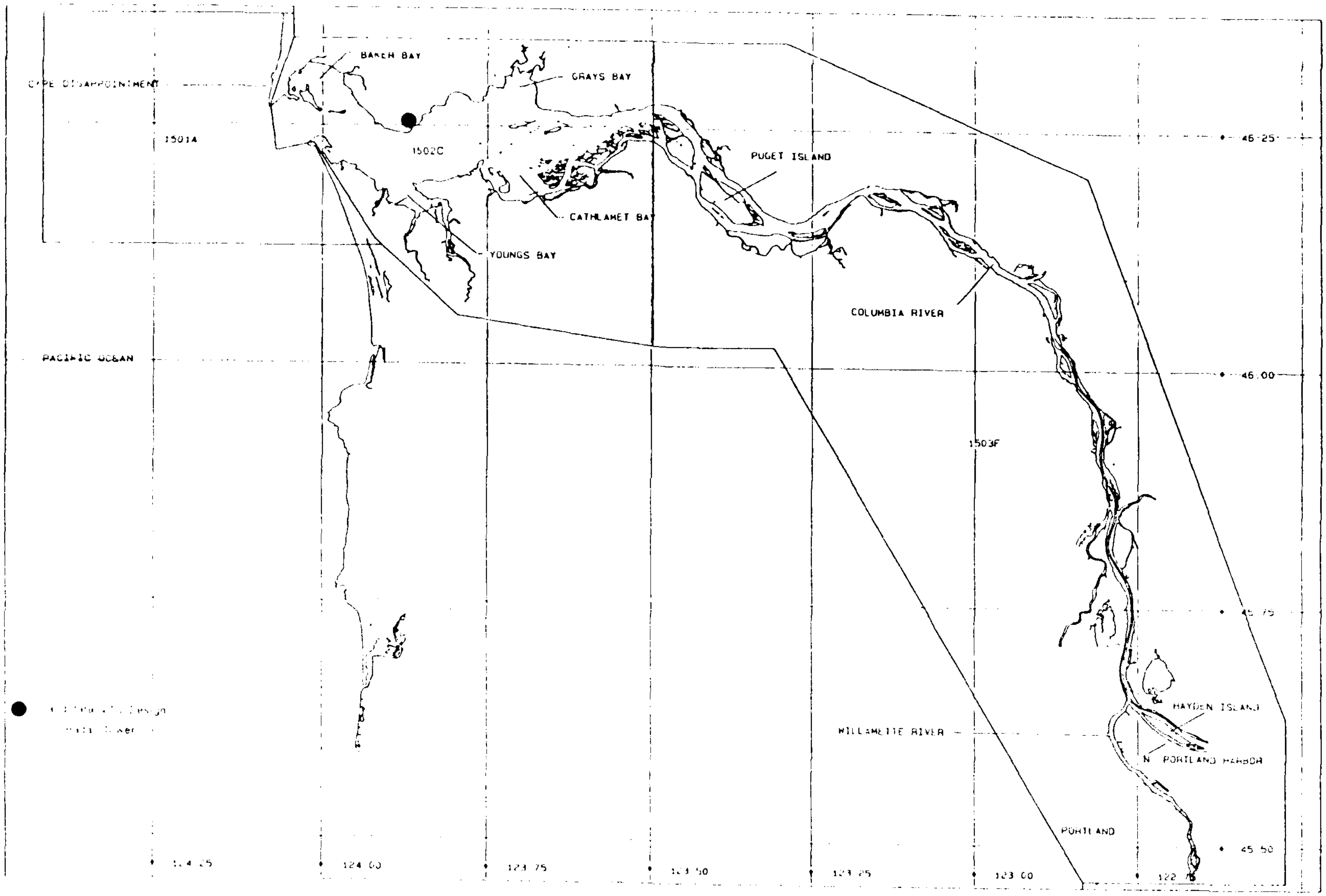
ZONE 15 - PORTLAND, OR - ZONE AND SUBZONE BOUNDARIES



ZONE 15 - PORTLAND, OR - DOMINANT VESSEL ROUTES AND COE WATERWAY CODES



ZONE 15 - PORTLAND, OR - BASE PERIOD (10 YEAR) VESSEL CASUALTIES



ZONE 15 - PORTLAND, OR - CANDIDATE VTS DESIGN RADAR LOCATIONS

CANDIDATE VTS DESIGN REPORT

FOR

PORTLAND, OR

(ZONE 15)

Prepared for:
U.S. Department of Transportation
Research and Special Programs Administration
John A. Volpe National Transportation Systems Center
Cambridge, MA 02142

Prepared by:
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7203 Gateway Court
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July 1991

OVERVIEW

The Candidate VTS Design described in this appendix is one of 23 developed for all the study zones included in the study. This appendix documents the task performed, under Contract DTRS-57-88-C-00088 Technical Task Directive 13, as an integral part of the total Port Needs Study. The ultimate product of this task effort is an informed preliminary technical assessment of the approximate cost to the Federal Government to implement and operate a state-of-the-art VTS system. This appendix does not contain a comprehensive definition of the VTS operating requirements nor does it propose a final VTS specification suitable for implementation.

In order to consistently estimate the life cycle costs of a VTS system in each of the study zones, a "Candidate VTS Design" has been defined for each study zone using a uniform set of design criteria. Each study zone Candidate VTS Design is a composite of generic modules selected from a master list of 18 state-of-the-art surveillance modules, communications and display technology. Among the surveillance modules in the master list are several levels of technical performance from which the selection is made for application to each study sub-zone to address the local navigational surveillance needs and conditions. The Candidate VTS Design in each study zone represents a consistent application of the surveillance modules at the sub-zone level. The sub-zone surveillance technology is subsequently integrated into a total system for the study zone via state-of-the-art communications and display consoles at the Vessel Traffic Center (VTC) in each zone.

The application of the surveillance modules in each sub-zone responds to the technical requirements of that sub-zone as perceived by the study team. The Candidate VTS Design represents a preliminary engineering judgement on the appropriate level of technology in each sub-zone. The Candidate VTS Design may be considered as an informed judgement made by the contractor study team for the sole purpose of developing cost estimates that are consistent across the 23 study zones and suitable for benefit/cost comparisons among the study zones and initial budget planning and implementation priorities. The approach used to calculate VTS system costs for all 23 study zones is found in Volume III, Technical Supplement.

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PORTLAND, OREGON VTS DESIGN

1.0 SCOPE

This report includes a port survey and a VTS design for Portland, Oregon. The port survey is based on a review of all pertinent literature including navigational charts. The methodology used to produce the VTS design entails coupling the problems identified in the port survey with solutions offered by state-of-the-art technology as identified in the VTS Technology Survey, November 1990. When possible, technological advances which permit manpower reductions are applied. Not all VTS problems are amenable to strictly technological solutions; some require changes in procedures and/or enforcement. These situations are identified where they occur.

2.0 PORT OF PORTLAND SURVEY

2.1 INTRODUCTION

This survey report is based exclusively upon review of available literature and examination of the charts for the area and its approaches. The information thus gained has been evaluated and interpreted based upon the Survey Team's experience as professional mariners and in vessel traffic management systems. The Study Area, in general terms, encompasses the Columbia River from its offshore approaches to Vancouver, Washington (WA); and the Willamette River from its junction with the Columbia to Portland, Oregon (OR). It thus includes a number of ports in addition to Portland, Oregon.

The Columbia River and its tributary, the Willamette River, is the most commercially important U. S. river system emptying into the Pacific Ocean. Deep-draft ships navigate the waterway to Portland and Vancouver, and barge traffic navigates the Columbia River to Pasco and Kenniwick, WA some 329 statute miles from the entrance. Commerce is considerable. Exports consist of logs, lumber and other forest products, grain, flour, chemicals, fruit, fish, general and containerized cargo. Imports via the waterway are coal, petroleum products, bulk salt, bulk cement, alumina, manufactured, general and containerized cargo.

Although similarities exist between traffic management requirements of this Study Area and the Port of New Orleans, the Columbia River is simpler from two standpoints. Deep-draft traffic is almost an order of magnitude less than it is at New Orleans and the barge traffic, although economically significant, is negligible by comparison.

The entire waterway must be considered as environmentally sensitive and is an important salmon spawning ground.

2.2 OVERVIEW OF THE PORT

The climate of the Study Area is marine at the entrance to the Columbia River and becomes continental as one heads upstream. Inland high and low temperatures are more extreme. Rain and fog occur less frequently at Portland than at the river mouth. At Astoria, fog drops winter visibility below 0.5 mile three to six days per month but is somewhat worse during late summer-early fall. At Portland visibility of 0.25 mile or less occurs about 22 days per year (Reference 1).

Mean ranges of tide on the Columbia River are 6.7 feet at Astoria to 1.3 feet at Vancouver. Tides can vary considerably from predictions because of changes in the river induced by upland rains and snow melt. Springtime freshets can, in addition to depth changes, cause rapid silting of dredged channels and move floating aids to navigation off station. Spring freshets in the Columbia River may also cause flow reversal in the Willamette River at least as far upstream as Portland. Currents in the waterway are strong and can be unpredictable, particularly at the river entrance. Ebb velocities at the bar can reach as high as eight knots but average about 3.5 knots on an annual basis. Strong ebbs coupled with strong westerly winds can create conditions which make the bar impassable even to large ships. During such conditions inbound shipping stands off and outbound traffic anchors in the river until conditions moderate.

Federal Project depths in the Columbia and Willamette Rivers are 48 feet over the bar, thence 40 feet to the Broadway Bridge at Portland; 40 feet from the confluence of the Columbia and Willamette Rivers through the lower turning basin at Vancouver; and thence 35 feet through the upper turning basin at Vancouver.

Pilotage across the Columbia River bar and up and down the river is not compulsory. Pilotage is provided by the Columbia River Bar Pilots for the bar and up river to Astoria, 12 miles inside the entrance. From Astoria up river, pilotage is provided by the Columbia River Pilots. Transfer from bar pilot to river pilot occurs off Astoria. Pilotage must be arranged through the pilots' offices by telephone or commercial radio, including INMARSAT, at least 12 hours in advance. Two pilot boats are used by the Bar Pilots, with the choice of boat used dependent upon weather conditions. The pilot boats monitor VHF-FM Channels 13 and 16. Working frequencies are Channels 13, 16, and 18A. The pilot boarding area for inbound ships is one mile east of the Columbia River Approach Lighted Horn Buoy CR. The Columbia River Bar Pilots maintain a fixed amber light atop their office at Astoria. When the light is exhibited it informs downbound shipping that the bar is closed and that ships should anchor to await improved conditions.

In addition to the two pilotage associations the Lewis and Clark Pilots are in the private employment of the PV Grain Company, which serves ships calling at the company's facilities. It is estimated that about 75% of the deep-draft ships carry pilots from one of the three organizations. In general, tugs and tows, warships, coastal tankers and small craft such as fishing vessels do not carry pilots.

Project channels throughout the river tend to be narrow, typically 400-600 feet wide, but there are some areas where natural width makes it possible to meet or pass comfortably. There are several Federal anchorages in the river, which provide lay-berths for ships awaiting cargo, bunkering or weather (see Section 2.3). Barge traffic can operate clear of the deep-draft channels in portions of the lower river.

Deep-draft traffic tends to time movements with the tide, thus introducing some natural order to the traffic flow. River pilots report an average of 5 meetings and 5 overtakings during the 85 mile trip from Astoria to Portland. These encounters are with vessels of all types.

The most difficult stretches of the river portion of the waterway are at Welch Island (Mile 32), Bugby Hole (Mile 40), Gull Island (Mile 54), Stella (Mile 57), Coffin Rock (Mile 74), Saint Helens (Mile 86) and Willamette (Mile 101).

Seasonal fishing, particularly gillnetting of salmon, creates congestion at and near the mouth of the Columbia River. This occurs annually, during late summer and early fall. Up to 2500 fishing boats may be at work in the area during that time. The most congested fishing area is normally in the vicinity of Columbia River Channel Buoy 10, and USCG patrol boats help keep fishing boats clear of deep-draft traffic.

A number of VHF-FM communications "blind-spots" exist throughout the Study Area and cellular telephones are increasingly being utilized to overcome the problem.

2.3 EXISTING TRAFFIC MANAGEMENT

2.3.1 Speed Limits

The Commander, 13th Coast Guard District has special administrative supervision of the Columbia and Willamette Rivers under which he is charged with enforcement of emergency regulations to govern navigation of these streams. The general nature of this authority, provided by 33CFR162.225, is the establishment of temporary speed limits during periods of freshets and high water.

2.3.2 Anchorages

Nine designated Federal anchorages have been established between Astoria and the head of deep-draft navigation at Vancouver and Portland. Regulations governing the anchorages are contained in 33CFR110.228. In general terms, the anchorages are intended for the use of deep-draft ships over 200' in length and may be considered as important resources for vessel traffic management.

Two of the anchorages, Henrici Bar Anchorage and Willow Bar Anchorage, are closed to shipping except for emergencies during the drift net fishing season as established by the State of Oregon.

2.3.3 Common Practice

Columbia River Pilots normally broadcast their positions when approaching significant turns. Arrival at each buoy is also broadcast during periods of low visibility. Neither practice is uniformly followed by vessels without pilots.

2.3.4 Proposed "Regulated Navigation Area"

The U. S. Coast Guard has developed a "Notice of Proposed Rule-making" (CGD13-90-04) with the intent that the "common practice" discussed in Section 3.3 be codified and made mandatory. The Notice provides for a "VTS Area" extending from the mouth of the Columbia River to the Interstate Route 5 Bridge at Vancouver (Columbia River Mile 106.5) and to the Steel Bridge at Portland (Willamette River Mile 12.1) within which communications rules will apply to:

Vessels over 20 meters in length.

Vessels over 8 meters in length engaged in towing another vessel astern, alongside, or by pushing ahead.

Dredges and floating plants.

The proposed communications rules require, among other things:

Maintenance of a guard on Channel 13 by vessels affected.

Announcements on Channel 13 of the following events:

When entering the VTS area, or getting underway from within it. The initial announcement is to contain the

name and description of the vessel, location, estimated time of entering the VTS area or of getting underway within it, the nature of the tow, if any, and the destination.

Announcements one mile or 10 minutes prior to arrival at Astoria (Mile 13), Three Tree Point (Mile 30.5), Bugby Hole (Mile 40), Gull Island Turn (Mile 55), and the mouth of the Willamette river (Mile 101).

2.3.5. Regulations governing Upper Columbia and Willamette Rivers

The U. S. Army Corps of Engineers regulates barge traffic on the Columbia River above Vancouver and the Willamette River above Portland, principally with respect to passage through the lock system of the upper rivers. From the standpoint of this Survey, the most significant element is size restrictions imposed upon tows to facilitate lockage. In general, for the Willamette River overall size of tows is limited to 150' length overall (LOA), 37' beam, and 6.5' draft. For the Columbia, the limits are 650' LOA, 84' beam, and 15' draft. There are some variations from these general figures for specific locks. Rules are summarized by the Coast Pilot (Reference 2).

2.4 VESSEL TRAFFIC

The major ports along the Columbia and Willamette Rivers handle some 40 million tons of cargo per year, about 10% of which consists of crude oil and petroleum products. In 1987, there were 414 tank ship movements within the waterway. Other movements that year included 3482 barge movements to and from facilities at Longview, Kalama and Portland.

According to the Columbia River Bar Pilots, Association members pilot about 4500 ships per year through the entrance channel. They estimate that this represents about 65% of the total traffic (Reference 3). Assuming this estimate is correct, there are approximately 6900 vessel movements per year between the sea and ports within the Study Area.

The repair yards in the Columbia and Willamette Rivers are highly competitive and represent an expanding business. Consequently, a number of the ship movements are of vessels just out of overhaul and offer the potential of a higher-than-average rate of mechanical failures of various types.

2.5 ENVIRONMENTAL SENSITIVITY

The Columbia and Willamette Rivers are important spawning grounds for Pacific salmon and pollution affecting the spawn undoubtedly represents the environmental threat having the greatest impact. The "Worst Case" pollution incident would thus be a major spill of crude oil or petroleum product at the beginning of the ebb at or

near the head of deep-draft navigation during or shortly after the spawning period. Given the river currents, such a spill could be carried well down river before containment was accomplished.

There are sensitive wetlands throughout the lower Columbia River area which are important to a variety of aquatic life. In addition to salmon, there are also other fisheries of smaller economic importance.

2.6 PORT SUB-ZONES

The Study Area was examined to determine appropriate sub-zones, using the methodology based upon the "confined-complex", "open-complex", "confined-simple" and "open-simple" system employed by the Canadian VTS Study in 1984 (Reference 3). Briefly stated, "open" and "confined" address the influence of geography upon a ship's ability to maneuver; and "simple" vs "complex" is descriptive of the nature of the interactions between ships within those geographic areas. This basic matrix was overlaid by a subjective assessment of appropriate traffic management/risk amelioration measures in order to derive sub-zones within which VTS needs are homogeneous, or nearly so.

2.6.1 Columbia River Approaches (NOAA Chart 18521)

The sub-zone consists of the deep-water approaches to the Columbia River Entrance seaward of a line connecting North Head Light, 46^0-17.9'N 124^0-11.8'W, 46^0-10'N 124^0-11.8'W and 46^0-10'N 123^0-58.4'W.

The purpose of the sub-zone is primarily to provide for reporting of Estimated Times of Arrival (ETA) and other data by inbound ships.

The sub-zone is classified as "open-simple."

2.6.2 Sub-Zone II -- Columbia River Entrance (NOAA Chart 18521)

The sub-zone lies between the inshore limit of Sub-Zone I (a line connecting North Head Light, 46^0-17.9'N 124^0-11.8'W, 46^0-10'N 124^0-11.8'W and 46^0-10'N 123^0-58.4'W) and a line drawn north across the Columbia River from Tongue Point Light (just upstream from Astoria).

The sub-zone encompasses the busy river entrance region, as well as the Port of Astoria. Activities within the sub-zone include pilot boarding areas, two Federal Anchorages and important centers of recreational boating and fishing activities. The Federal Project channels vary in width from 2640' at the Entrance to 500' in the upper ranges. The sub-zone provides opportunity for queuing as necessary to prevent unacceptable meetings or overtakings in the narrow waterways of Sub-Zone III and is a critical holding area for outward bound shipping awaiting bar passage.

VTS design for the sub-zone should, in addition to communications, provide for navigational assistance, regulation of traffic flow and anchorage management.

The sub-zone is "confined-complex."

2.6.3 Sub-Zone III Columbia River (NOAA Charts 18521, 18523, 18524 & 18526)

The sub-zone lies between the upriver boundary of Sub-Zone II (a line drawn north across the Columbia River from Tongue Point Light) and the Interstate Route 5 Bridge across the Columbia River at Vancouver. No portion of the Willamette River is included in the sub-zone.

The sub-zone embraces over 80 miles of river, with a number of blind turns, several ports and a number of Federal Anchorages. Traffic is a mixture of deep-draft and barges. Some commercial fishing occurs in stretches of the sub-zone in season, and the river is widely used for recreation.

There are numerous VHF-FM "dead spots" within the sub-zone, making Channel 13 communications unreliable. The Federal Project channels are predominantly 600' in width, but reduce to 500' in the upper reaches. There are locations where natural widening permit comfortable passing, but currents and the speed required for downbound ships to retain control make meetings of ships with beams over 100' challenging at best and hazardous at worse.

Channel widths rule out cross-track navigational assistance. Given the relatively low volume of traffic, along-track information can probably be obtained through refinements to the proposed "Regulated Navigation Area" reporting procedures. Speed regulations may be imposed as required by the river level, and selected anchorages are closed to deep-draft use during designated fishing seasons.

The sub-zone is classified as "confined-simple."

2.6.4 Sub-Zone IV -- Upper Columbia River (NOAA Chart 18526)

The sub-zone consists of the navigable portion of the Columbia River upstream of the Interstate Route 5 Bridge at Vancouver.

The sub-zone serves as a data catchment area, to introduce into the VTS database information about downbound barge traffic in advance of its entry into the VTS service area. This can be obtained by imposition of reporting requirements.

The s b-zone is classified "confined-simple."

2.6.5 Sub-Zone V -- Portland (NOAA Chart 18526)

The sub-zone consists of that portion of the Willamette River between its junction with the Columbia River and the Steel Bridge across the Willamette River at Portland.

The sub-zone consists of that portion of the Willamette River forming the site of the facilities of the port of Portland. Ships and tows maneuver to make and clear berths within the sub-zone and there is one channel junction at the point where Swan Island Basin joins the river.

The sub-zone is classified "confined-complex."

2.6.6 Sub-Zone VI -- Upper Willamette River (NOAA Chart 18526)

The sub-zone consists of that portion of the Willamette River upstream of the Steel Bridge at Portland.

The sub-zone serves as a data catchment area, to introduce into the VTS database information about downbound barge traffic in advance of its entry into the VTS service area. This can be obtained by imposition of reporting requirements.

The sub-zone is "confined-simple."

2.7 PROBLEM ARF- IDENTIFIERS

2.7.1 PAI II-1. Columbia River Channel Buoy 10 (NOAA Chart 18521)

This PAI, centered upon Columbia River Channel Buoy 10, includes gillnetting activities occurring between the entrance channel jetties and the fishing/recreational boating traffic associated with Ilwaco Harbor.

These activities occur at a point where the deep-draft channel makes a major course change of approximately 110^0, part of which is athwart the primary axis of both river and tidal currents. The deep-draft channel is sufficiently wide to permit the VTS to assist with navigational information, if required, in addition to

regulating the traffic flow so as to minimize the potential for incidents. This should include, among other things, the ability to provide advance warning to gillnetters of intended deep-draft transits.

2.7.2 PAI II-2. Astoria (NOAA Chart 18521)

This PAI includes the Astoria waterfront, the Federal Anchorages on either side of the Astoria Range Channel and the pilot exchange point where Columbia River Bar and Columbia River Pilots leave and depart ships. There is considerable activity from small craft, both recreational boats and fishing craft, bound to and from facilities in Young's Bay and Astoria. The Federal Anchorages are important to the queuing of both inbound and outbound shipping and during adverse weather serve as a holding area for outbound ships awaiting opening of the bar.

VTS capabilities should include management of the anchorages and regulation of the smooth and safe flow of traffic. The main channels are sufficiently narrow so that cross-track navigational assistance is not feasible, but along-track information is important to the overall management capability.

2.7.3 PAI III-1. Welch Island (NOAA Chart 18523)

The five mile length of channel centered north of Welch Island (Columbia River Statute Mile 32) is a location identified by the Columbia River Pilots as among the more difficult portions of the river. The bend necessitates a continuous change in course of about 90^0 over several miles and intervening land can screen other traffic from view. Meetings of deep-draft ships at this point should be avoided.

2.7.4 PAI III-2. Bugby Hole (NOAA Chart 18523)

The channel in the vicinity of Bugby Hole (Columbia River Statute Mile 40) is a location identified by the Columbia River Pilots as among the more difficult portions of the river. A 30^0 course change occurs at a point where the river is particularly narrow. Downbound ships tend to be carried by the current across the channel centerline and land mass can obscure sightings of oncoming traffic. Meetings of deep-draft ships at this point should be avoided.

2.7.5 PAI III-3. Crims Island (NOAA Chart 18523)

The channel above Crims Island (Columbia River Statute Mile 55) is a location identified by the Columbia River Pilots as among the more difficult portions of the river. A course change occurs at a point where land masses affect visibility and the port facilities at the entrance to Bradbury Slough, with their associated activities, are located just downstream from the turn.

2.7.6 PAI III-4. Slaughters Channel Federal Anchorage (NOAA Chart 18524)

The anchorage (Columbia River Statute Mile 65) is an important resource for the management of traffic, both as a lay-berth area and as a point where there is ample room for the meeting or overtaking of large ships.

2.7.7 PAI III-5. Coffin Rock (NOAA Chart 18524)

The channel in the vicinity of Coffin Rock (Columbia River Statute Mile 72.5) is a location identified by the Columbia River Pilots as among the more difficult portions of the river. The current runs strongly along this reach of the river and land masses affect visibility.

2.7.8 PAI III-6. Kalama Anchorage (NOAA Chart 18524)

The anchorage (Columbia River Statute Mile 75) is an important resource for the management of traffic, both as a lay-berth area and as a point where there is ample room for the meeting or overtaking of large ships.

2.7.9 PAI III-7. Columbia City Anchorage (NOAA Chart 18524)

The anchorage (Columbia River Statute Mile 84) is an important resource for the management of traffic, both as a lay-berth area and as a point where there is ample room for the meeting or overtaking of large ships.

2.7.10 PAI III-8. Saint Helens (NOAA Chart 18524)

The area of Saint Helens (Columbia River Statute Mile 85) is a location identified by the Columbia River Pilots as among the more difficult portions of the river. A bifurcation of the channel occurs permitting ships drawing 26' or less to serve the facilities of Saint Helens and vicinity, plus minor traffic joins and leaves the river at the entrance to the Lewis River (Statute Mile 87).

2.7.11 PAI III-9. Henrici Channel Anchorage (NOAA Chart 18524)

The anchorage (Columbia River Statute Mile 91.5) is an important resource for the management of traffic, both as a lay-berth area and as a point where there is ample room for the meeting or overtaking of large ships. The anchorage is closed to shipping except in emergencies during certain fishing periods. At those times shipping may experience congestion caused by fishing boats operating in the vicinity of the anchorage.

2.7.12 PAI III-10. Willow Bar Anchorage (NOAA Chart 18524)

The anchorage (Columbia River Statute Mile 96.25) is an important resource for the management of traffic, both as a lay-berth area and as a point where there is ample room for the meeting or overtaking of large ships. The anchorage is closed to shipping except in emergencies during certain fishing periods. At those times shipping may experience congestion caused by fishing boats operating in the vicinity of the anchorage.

2.7.13 PAI III-11. Willamette River Junction (NOAA Chart 18524)

The juncture of the Willamette and Columbia Rivers is a point at which two traffic streams merge. Downbound shipping from Portland must cross upbound traffic for Vancouver at a point where visibility is limited by land masses. Two anchorages are located just upstream from the junction at a point where vessels using North Portland Harbor leave and depart the main channel.

The area is also a location identified by the Columbia River Pilots as among the more difficult portions of the river.

2.7.14 PAI V-1. Portland (NOAA Chart 18526)

The activity level at Portland is probably higher than at any other single point along the river. Vessels making and departing berths, negotiating bridges and entering/leaving side channels like the Swan Island Basin introduce a random movement which is generally absent elsewhere. The overall volume probably does not warrant real-time surveillance but good information exchange and adherence to Bridge-to-Bridge radiotelephone requirements is critical to safety.

3.0 PORTLAND, OREGON VTS DESIGN

3.1 INTRODUCTION

A detailed survey of the Port of Portland is the basis for this design. An approach to costing VTS systems is outlined in Vol. III, Technical Supplement and a method of categorizing surveillance sensors into "modules" has also been developed. These modules are defined in terms of cost and performance and are to be applied to all VTS designs in this study. The applicability of Automatic Dependent Surveillance (ADS) technology is also discussed in this report. The six sub-zones defined in the harbor survey remain the same.

Traffic management requirements for each sub-zone are developed from PAI analysis. Table 3-1 lists in tabular form a summation of the problems identified and the management required by sub-zone.

The hardware and software selected for this design provide the level of surveillance justified by the problems identified in each sub-zone. A secondary consideration is to locate all VTS assets so that they are sufficient for the sub-zone in question and can contribute to adjoining sub-zones to achieve maximum usage. All specific equipments are then selected based on perceived surveillance requirements and overall VTS system architecture.

3.1.1 VTS Design Approach

The choice of surveillance sensors is dependent on the VTS mission. For the purposes of this design, the VTS mission is defined as that which insures the safety of navigation and the protection of the environment. In order to accomplish this mission, mandatory participation of all vessels over 20 meters is essential. The Vessel Traffic Center (VTC) must provide navigation safety advice to all vessels. The VTS in the United States will have no facilitation of commerce role nor will it offer piloting assistance of any kind.

The primary criteria for selection of adequate surveillance sensors are:

- o Percentage of vessels of the desired minimum size detected in designated surveillance areas
- o Percentage of lost tracks
- o Accuracy of the position and track obtained
- o Reliability of the surveillance system
- o Timeliness of the data obtained
- o Ability to interpret and use the data obtained

Secondary criteria are:

- o Cost of the VTS system -- reduction of manpower by the use of technology
- o Expandability -- increased VTS responsibility, area, and/or support of other missions

TABLE 3-1. PORTLAND, OR PROBLEM AREA IDENTIFIERS

PAI	LOCATION	PROBLEM	MANAGEMENT
I	Columbia River Approaches	Data catchment area for inbound shipping	Have knowledge of ship movement, intentions and characteristics. Enter inbound traffic into database.
II	Columbia River Entrance	Potential congestion, dissimilar traffic. Navigational assistance may be required. Queuing may be necessary to prevent unacceptable meetings, coupled with effective use of anchorages.	Have real-time knowledge of vessel movements. Be able to provide navigational assistance. Have real-time information of fishing activities. Provide movement management advice as required. Control anchorages as required.
III	Columbia River	Narrow channels where meetings, overtakings must be managed. Potential for localized congestion. Queuing control required, coupled with anchorage management.	Have knowledge of vessel movements and locations based upon movement reporting system. Provide movement management advice, control anchorages. Know river state and details of non-shipping activities.
IV	Upper Columbia River	Data catchment area for traffic downbound for Sub-Zone II.	Have knowledge of vessel movements, in-tentions and characteristics. Enter into shipping database.
V	Portland	Potential congestion. Queuing control required for downbound traffic.	Have knowledge of vessel movements, locations and intentions based upon movement reportng system. Provide move-ment management advice.
VI	Up Willamette River	Data catchment area for vessels downbound to Sub-Zone V.	Have knowledge of vessel movement, intentions, characteristics. Enter in database.

Active surveillance sensors including radar, communications, and closed circuit television (CCTV) installations are used when detection and tracking of vessels is paramount to providing safety advice. These devices are considered fail safe in that it is known with certainty when they have failed. The performance characteristics of these sensors are known from operational VTS worldwide experience. In this design they are selected to assure that the necessary operational criteria identified for each sub-zone is realized.

Many dependent surveillance techniques are possible. These range from voice radio reporting of required VTS data to automatic position and identification recording devices that can be interrogated from shore known as Automatic Dependent Surveillance (ADS) devices. The position and/or movement reporting form of dependent surveillance is used extensively in existing VTS systems. The major regions of current use are those which do not require active surveillance. To apply ADS technology to a specific sub-zone within a VTS zone the following additional criteria must be considered:

- The number and class of vessels interacting in the sub-zone and which of these interactions are important to the VTS mission. Obviously all vessel classes of interest must be appropriately equipped. This requires that all vessels of the classes selected which will ever pass through this sub-zone must be equipped with an ADS device. This requirement to detect so many different vessels argues against the use of ADS. In areas where only one class of vessel is of interest, ADS is more easily implemented.

- The interactions or transits to be monitored must not demand that the surveillance be fail safe, i.e. positively detecting failures. This type of surveillance is related to position reporting in that it may not always function or be used properly and the VTS has limited control over its operation.

- It must be determined that if active surveillance is not justified, the additional information obtained from ADS over position reporting is necessary.

- If the class or group of vessels to be monitored is a "controllable" group, ADS can be easily implemented and satisfactory operation more readily achieved. Controllable means a clearly defined subset of vessels, e.g. a specific barge company; vessels carrying a specific cargo, etc.

- The number of different vessels in each class of interest that passes through the sub-zone in question must be determined. This number must be known to accurately estimate the cost of selecting this option for this sub-zone.

- A specific ADS solution for one sub-zone in one harbor may affect all the VTS designs for all the other sub-zones in all the other harbors.

3.1.2 Assumptions

The design of this VTS system starts with a set of assumptions based on the detailed survey and other data. These assumptions are as follows:

- As recommended by the IMO, all vessels of 20 meters or more in length are required to participate in the VTS. Participation is defined (at a minimum) as monitoring the VTS frequency and reporting as required.

- The VTS system is implemented with the cooperation and assistance of the port authorities, pilots associations, and marine exchange, if any. The existing facilities, services, and procedures established and operated by these organizations are major elements of an integrated VTS system as defined in the IMO VTS Guidelines.

- The life-cycle of all system hardware is ten years.

3.2 DESIGN DECISIONS (FIGURE 3-1)

3.2.1 General

Examination of the traffic levels, geographical features and identified problem areas in the port leads to the following selection and location of sensor hardware.

3.2.2 Hardware Location and Selection

3.2.2.1 Sub-Zone I

<u>Point Ellice Site</u>	1 Module 3 radar 1 Module 11 VHF
<u>USCG Moorings Site</u>	1 Module 10 VHF 1 Module 13 MET

Surveillance Modules -Sub Zones	RADAR						ADS			VHF		MET.		HYD.		DF	CCTV		COMMENTS
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
I																			Required VHF capability will be located in Sub-zone II
II			1							1	1		1						
III										8	4		2						
IV																			
V										1			1						
VI										1									

FIGURE 3-1. PORTLAND, OR SURVEILLANCE SURVEY

3.2.2.2 Sub-Zone III

VHF and MET equipment as follows:

Mile 33.5 near Skamokawa	1 Module 10
Mile 44 near Westport	1 Module 10, 11
Mile 53.5 near Port Westware	1 Module 10
Mile 65 near Longview	1 Module 10, 11
Mile 75 near Kalama	1 Module 10, 13
Mile 86 near St. Helens	1 Module 10, 11
Mile 95 near Knapp	1 Module 10
Mile 105 near Vancouver	1 Module 10, 11, 13

3.2.2.3 Sub-Zone V

Portland Site	1 Module 10 VHF
	1 Module 13 MET

3.2.2.4 Sub-Zone VI

Fulton Site	1 Module 10 VHF

3.2.3 Vessel Traffic Center

The design of the hardware and software should be modern and capable of operating with reduced staff levels and no loss of effectiveness. One watchstander and one supervisor (half-time) with integrated data workstations and decision aiding software can effectively manage the activity in this port. This Vessel Traffic Center concept demands that the watchstander be separated from any other harbor/port information requests. The Center must be structured so that such requests are controlled by a bulletin board type interface. One officer-in-charge and one clerk are also required for the proper administration of the facility.

The Vessel Traffic Center is located in Astoria in a location with good visual surveillance of the river entrance and the Astoria area. The center is to employ the following equipment:

3.2.3.1 VTS Console

This console provides total data integration from all sensors in all sectors. These data are graphically shown on raster scan, high light level, color displays. A data display is also provided. Console design architecture is general purpose computer based, open architecture, bus organized, allowing operation of the system as a local area network (LAN). Data interchange with other facilities by modem is provided as well as interface with the U.S. Coast Guard standard terminal. The design allows board level modification and expansion. Features of the software and hardware provided are:

- Software written in a high level language.

- Software providing the total integration of data from all VTS sensors.

- Layering of data in at least four layers to be operator selectable.

- The ability to sector data including sector to sector handoff of targets.

- The ability to accept external digital data derived from transmissions of shipboard transponders or other sources and integrate the information with all other sensor data.

- Automatic and/or manual acquisition of radar targets including automatic tracking and target ID assignments. Guard zones with automatic acquisition of all targets entering the zone.

- Several warning levels of vessel interaction designed to direct attention to developing situations rather than a simple CPA alarm strategy.

- Complete vessel monitoring and alarm capability including anchor watch, CPA, TCPA, track history, adjustable target velocity vectors, restricted area penetration and maneuvering monitor is provided. Additional warning and/or alarm features allowed by programming changes in high level language.

- Complete modern color graphics capability with offset and zoom

- Complete harbor navigation aid monitoring capability including buoy position, light status, etc.

- Remote control of all radars and radar interfaces as well as radar data processing including site-to-site integration, clutter suppression, scan conversion and target extraction.

- Complete track projection capability which can predict and/or analyze future interactions based on current position, destination and velocity.

- The capability of constructing a complete vessel data base and interfacing it to the real-time data display from the VTS sensors.

3.2.3.2 Communications Console

This console is capable of remotely operating the proposed transmitting/receiving sites and allowing transmission and monitoring on all required frequencies. The console provides two operating positions each to be capable of complete communications control. It is capable of modular expansion if other remote communications sites are added.

3.2.3.3 Supervisor Control and Data Acquisition (SCADA) Equipment

A SCADA capability is provided to the major module level at remote sites so that the watchstander can determine the status of the entire VTS system. A graphic readout is provided in block diagram form indicating operational status of all elements in the system. Security monitoring of remote sites is also included.

3.2.3.4 Recording Equipment

Time synchronized video and audio recording equipment is to be provided. This equipment is capable of recording and playing back the data presented to the VTS watchstander and his reaction to the situation. An extra set of recording equipment is to be installed for redundancy purposes.

3.3 COST ESTIMATES

3.3.1 General

Vol. III, Technical Supplement discusses a generalized approach to estimating VTS system costs. This approach is based on interviews with system designers and purchasers of recently constructed systems. The cost of this VTS system has been estimated using this approach and is detailed below. The assumptions made in estimating these costs are listed in Paragraph 3.1.2.

3.3.2 Hardware (x $1000)

<u>Vessel Traffic Center</u>	non-recurring	recurring(10-yr)
VTS Console (1 workstation one supervisory console & all software)	750	
Communications console	200	
Recording Equipment	100	
SCADA Equipment (1 radar site)	100	
Sub-Total:	1150	600

Sub-Zone I--Columbia River Approaches (NOAA Chart 18521)

Required VHF capability to be located in Sub-Zone II.

Sub-Zone II--Columbia River Entrance (NOAA Chart 18521)

1 Module 3 radar	400	400
1 Module 10 VHF	19	13
1 Module 11 VHF	48	20
1 Module 13 MET	40	5
Sub-total:	507	438

Sub-Zone III--Columbia River (NOAA Charts 18521, 18523, 18524 & 18526)

8 Module 10 VHF	152	104
4 Module 11 VHF	192	80
2 Module 13 MET	80	10
Sub-total:	424	194

Sub-Zone IV--Upper Columbia River (NOAA Chart 18526)

No facilities here.

Sub-Zone V--Portland (NOAA Chart 18526)

1 Module 10 VHF	19	13
1 Module 13 MET	40	5
Sub-total:	59	18

Sub-Zone VI--Upper Willamette River (NOAA Chart 18526)

1 Module 10 VHF	19	13
Sub-Total:	19	13
HARDWARE TOTALS:	$2159	$1264

3.3.3 Project Totals (x $1000)

Non-recurring

Hardware	$2159
Management, Engineering, etc. (50%) Assumptions: Turnkey system, Procurement by integ.contractor, good manufacturer support, some software provided, System Manual required	1080
Installation site integration (20%) Assumptions: Complete installation by contractor, remote access no serious problem, many widespread sites	432
Spares & Training (10%)	216
Civil Engineering 1 remote radar site, a VTC in Astoria, remote comms and WX sensors installations, minor land acquisition, no roads	1500
PROJECT ESTIMATE:	5387
Data Base Management System	300
TOTAL: (non-recurring)	$ 5687

Recurring (10 year)

Hardware	1264
1 Watchstander x 5 = 5 man/years @ 50K x 10	2500
1 Watch Supervisor (1/2 time)	1250
1 Officer-in-Charge	500
1 Clerk	500
TOTAL: (recurring) (10-year life)	$ 6014
TOTAL 10-YEAR PROJECT COST:	$11701

REFERENCES

1. United States Coast Pilot: Pacific Coast, California, Oregon, Washington, and Hawaii, 25th Edition. NOAA, Washington, D.C., 1989, pp. 224, T-6 amd T-15.

2. United States Coast Pilot: Pacific Coast, California, Oregon, Washington, and HAwaii, 25th Edition. NOAA, Washington, D.C., 1989, pp. 80-87, 1990.

3. Final Report, National Vessel Traffic Services Study (TP5965E), Canadian Coast Guard, Ottawa, 1984, pp. 89-91.

GLOSSARY

ADS: Automatic Dependent Surveillance

ARPA: Automatic Radar Plotting Aid.

"CONFINED-COMPLEX": a combination of terms relating to the geography and the nature of the interactions between ships. See Final Report National Vessel Traffic Services Study (TP-5965E), Canadian Coast Guard, Ottawa, October 1984, pp.89-91.

"CONFINED-SIMPLE": a combination terms relating to the geography and the nature of the interactions between ships. See Final Report National Vessel Traffic Services Study (TP-5965E), Canadian Coast Guard, Ottawa, October 1984, pp.89-91.

COTP: Captain of the Port

CCTV: closed circuit television

COLREGS LINE: a demarcation line delineating those waters upon which international regulations for the prevention of collisions at sea apply.

CPA: closest point of approach

DBMS: data base management system

DF: direction finder

FAA: Federal Aviation Administration

GIS: Geographic Information System

ICW: Intracoastal Waterway

IMO: International Maritime Organization

KW: Kilowatt

LAN: local area network

LLOYD'S LIST: a listing of all merchant vessels of the world including their physical characteristics. Published by Lloyd's of London.

LNG: liquified natural gas

NOAA: National Oceanic and Atmospheric Administration

"OPEN-COMPLEX": a combination of terms relating to the geography and the nature of the interactions between ships. See Final Report National Vessel Traffic Services Study (TP-5965E), Canadian Coast Guard, Ottawa, October 1984, pp. 89-91.

"OPEN-SIMPLE": a combination of terms relating to the geography and the nature of the interactions between ships. See Final Report National Vessel Traffic Services Study (TP-5965E), Canadian Coast Guard, Ottawa, October 1984, pp. 89-91.

PAI: Problem Area Identifier

PRECAUTIONARY AREA: an area normally an intersection, entrance to, or exit from a traffic separation scheme where vessel interactions are unpredictable

SCADA: Supervisor Control and Data Acquisition

TCPA: time of closest point of approach

TRAFFIC SEPARATION SCHEME: routes incorporating traffic separation to increase the safety of navigation, particularly in converging areas of high traffic density.

VHF: very high frequency

VTC: vessel traffic center

VTS: vessel traffic services

STUDY ZONE INPUT DATA AND OUTPUT STATISTICS

TABLE 1 Assignment of COE Waterway Codes to Subzones 8/06/91

COE Waterway		Name
Subzone 1501A		
4606	A	SKIPANON CHANNEL, OREG.
4608	A	YOUNGS BAY AND YOUNGS RIVER, OREG.
4608	B	YOUNGS BAY AND YOUNGS RIVER, OREG.
4610	A	PORT OF ASTORIA, OREG.
4614	A	DEEP RIVER, WASH.
4618	A	WESTPORT SLOUGH, OREG.
4620	A	CLATSKANIE RIVER, OREG.
4622	A	PORT OF LONGVIEW, WASH.
4624	A	COWLITZ RIVER, WASH.
4626	A	PORT OF KALAMA, WASH.
4628	A	PORT OF ST. HELENS, OREG.
4630	A	MULTNOMAH CHANNEL, OREG.
4632	A	LEWIS RIVER, WASH.
4634	A	OREGON SLOUGH (NORTH PORTLAND HARBOR), OREG.
4636	A	PORT OF VANCOUVER, WASH.
4644	A	PORT OF PORTLAND, OREG.
4683	A	SKAMOKAWA CREEK, WASH.
4684	A	SKAMOKAWA (STEAMBOAT) SLOUGH, WASH.
4685	A	LAKE RIVER, WASH.
Subzone 1502C		
4606	A	SKIPANON CHANNEL, OREG.
4606	B	SKIPANON CHANNEL, OREG.
4608	A	YOUNGS BAY AND YOUNGS RIVER, OREG.
4608	B	YOUNGS BAY AND YOUNGS RIVER, OREG.
4610	A	PORT OF ASTORIA, OREG.
4610	B	PORT OF ASTORIA, OREG.
4614	A	DEEP RIVER, WASH.
4614	B	DEEP RIVER, WASH.
4618	A	WESTPORT SLOUGH, OREG.
4618	B	WESTPORT SLOUGH, OREG.
4620	A	CLATSKANIE RIVER, OREG.
4620	B	CLATSKANIE RIVER, OREG.
4622	A	PORT OF LONGVIEW, WASH.
4622	B	PORT OF LONGVIEW, WASH.
4624	A	COWLITZ RIVER, WASH.
4624	B	COWLITZ RIVER, WASH.
4626	A	PORT OF KALAMA, WASH.
4626	B	PORT OF KALAMA, WASH.
4628	A	PORT OF ST. HELENS, OREG.
4628	B	PORT OF ST. HELENS, OREG.
4630	A	MULTNOMAH CHANNEL, OREG.
4630	B	MULTNOMAH CHANNEL, OREG.
4632	A	LEWIS RIVER, WASH.
4632	B	LEWIS RIVER, WASH.
4634	A	OREGON SLOUGH (NORTH PORTLAND HARBOR), OREG.
4634	B	OREGON SLOUGH (NORTH PORTLAND HARBOR), OREG.
4636	A	PORT OF VANCOUVER, WASH.
4636	B	PORT OF VANCOUVER, WASH.
4644	A	PORT OF PORTLAND, OREG.
4644	B	PORT OF PORTLAND, OREG.
4683	A	SKAMOKAWA CREEK, WASH.
4683	B	SKAMOKAWA CREEK, WASH.
4684	A	SKAMOKAWA (STEAMBOAT) SLOUGH, WASH.
4684	B	SKAMOKAWA (STEAMBOAT) SLOUGH, WASH.
4685	A	LAKE RIVER, WASH.
4685	B	LAKE RIVER, WASH.

TABLE 1 Assignment of COE Waterway Codes to Subzones 8/06/91

COE Waterway		Name
Subzone 1503F		
4618	A	WESTPORT SLOUGH, OREG.
4618	B	WESTPORT SLOUGH, OREG.
4620	A	CLATSKANIE RIVER, OREG.
4620	B	CLATSKANIE RIVER, OREG.
4622	A	PORT OF LONGVIEW, WASH.
4622	B	PORT OF LONGVIEW, WASH.
4624	A	COWLITZ RIVER, WASH.
4624	B	COWLITZ RIVER, WASH.
4626	A	PORT OF KALAMA, WASH.
4626	B	PORT OF KALAMA, WASH.
4628	A	PORT OF ST. HELENS, OREG.
4628	B	PORT OF ST. HELENS, OREG.
4630	A	MULTNOMAH CHANNEL, OREG.
4630	B	MULTNOMAH CHANNEL, OREG.
4632	A	LEWIS RIVER, WASH.
4632	B	LEWIS RIVER, WASH.
4634	A	OREGON SLOUGH (NORTH PORTLAND HARBOR), OREG.
4634	B	OREGON SLOUGH (NORTH PORTLAND HARBOR), OREG.
4636	A	PORT OF VANCOUVER, WASH.
4636	B	PORT OF VANCOUVER, WASH.
4644	A	PORT OF PORTLAND, OREG.
4644	B	PORT OF PORTLAND, OREG.
4683	A	SKAMOKAWA CREEK, WASH.
4683	B	SKAMOKAWA CREEK, WASH.
4684	A	SKAMOKAWA (STEAMBOAT) SLOUGH, WASH.
4684	B	SKAMOKAWA (STEAMBOAT) SLOUGH, WASH.
4685	A	LAKE RIVER, WASH.
4685	B	LAKE RIVER, WASH.

Appendix O Zone 15 Portland, OR 7/15/91

TABLE 2 Base Year 1987 Cargo Tons by Subzone, Commodity, and Vessel Type

Subzone 1501A

Comm. Code	Name	Dry Cargo	Tanker	Dry Cargo Barge Tow	Tanker Barge Tow	Total
1	FARM PRODUCTS	17,422,550	0	5,049,590	0	22,472,140
2	FOREST PRODUCTS	4,062	0	0	0	4,062
3	FISHERIES PRODUCTS	6,621	0	0	0	6,621
4	MINING PRODUCTS, NEC	2,516,125	0	3,065,962	0	5,582,087
5	PROC. FOODS & MFTRS, NEC	11,906,618	0	2,791,306	0	14,697,924
6	WASTE OF MANUFACTURING	377,826	0	70,440	0	448,266
1311	CRUDE PETROLEUM	0	771,266	0	0	771,266
2810	SODIUM HYDROXIDE (CAUSTI	103,029	0	0	0	103,029
2811	CRUDE PROD-COAL TAR-PET	6,139	0	0	0	6,139
2813	ALCOHOLS	0	109,411	0	0	109,411
2817	BENZENE AND TOLUENE	0	63,835	0	0	63,835
2871	NITROGEN CHEM FERTILIZER	0	171,837	0	52,912	224,749
2872	POTASSIC CHEM FERTILIZER	1,057	0	0	0	1,057
2911	GASOLINE, INCL NATURAL	0	710,928	0	631,715	1,342,643
2912	JET FUEL	0	81,283	0	47,024	128,307
2914	DISTILLATE FUEL OIL	0	412,051	0	753,151	1,165,202
2915	RESIDUAL FUEL OIL	0	347,750	0	821,004	1,168,754
2916	LUBRIC OILS-GREASES	0	172,626	0	11,774	184,400
2917	NAPHTHA, PETRLM SOLVENTS	0	6,253	0	0	6,253
2921	LIQUI PETR-COAL-NATR GAS	0	84	0	0	84
	Subzone Total :	32,344,027	2,847,324	10,977,298	2,317,580	48,486,229

Subzone 1502C

Comm. Code	Name	Dry Cargo	Tanker	Dry Cargo Barge Tow	Tanker Barge Tow	Total
1	FARM PRODUCTS	17,422,550	0	5,049,590	0	22,472,140
2	FOREST PRODUCTS	4,062	0	0	0	4,062
3	FISHERIES PRODUCTS	6,621	0	0	0	6,621
4	MINING PRODUCTS, NEC	2,516,125	0	3,065,962	0	5,582,087
5	PROC. FOODS & MFTRS, NEC	11,906,618	0	2,791,306	0	14,697,924
6	WASTE OF MANUFACTURING	377,826	0	70,440	0	448,266
1311	CRUDE PETROLEUM	0	771,266	0	0	771,266
2810	SODIUM HYDROXIDE (CAUSTI	103,029	0	0	0	103,029
2811	CRUDE PROD-COAL TAR-PET	6,139	0	0	0	6,139
2813	ALCOHOLS	0	109,411	0	0	109,411
2817	BENZENE AND TOLUENE	0	63,835	0	0	63,835
2871	NITROGEN CHEM FERTILIZER	0	171,837	0	52,912	224,749
2872	POTASSIC CHEM FERTILIZER	1,057	0	0	0	1,057
2911	GASOLINE, INCL NATURAL	0	710,928	0	631,715	1,342,643
2912	JET FUEL	0	81,283	0	47,024	128,307
2914	DISTILLATE FUEL OIL	0	412,051	0	753,151	1,165,202
2915	RESIDUAL FUEL OIL	0	347,750	0	821,004	1,168,754
2916	LUBRIC OILS-GREASES	0	172,626	0	11,774	184,400
2917	NAPHTHA, PETRLM SOLVENTS	0	6,253	0	0	6,253
2921	LIQUI PETR-COAL-NATR GAS	0	84	0	0	84
	Subzone Total :	32,344,027	2,847,324	10,977,298	2,317,580	48,486,229

Appendix O Zone 15 Portland, OR 7/15/91

TABLE 2 Base Year 1987 Cargo Tons by Subzone, Commodity, and Vessel Type

Subzone 1503F

Comm. Code	Name	Dry Cargo	Tanker	Dry Cargo Barge Tow	Tanker Barge Tow	Total
1	FARM PRODUCTS	17,323,170	0	5,049,590	0	22,372,760
2	FOREST PRODUCTS	4,062	0	0	0	4,062
3	FISHERIES PRODUCTS	6,621	0	0	0	6,621
4	MINING PRODUCTS, NEC	2,516,125	0	2,711,452	0	5,227,577
5	PROC. FOODS & MFTRS, NEC	11,431,109	0	2,671,984	0	14,103,093
6	WASTE OF MANUFACTURING	377,826	0	70,440	0	448,266
1311	CRUDE PETROLEUM	0	771,266	0	0	771,266
2810	SODIUM HYDROXIDE (CAUSTI	103,029	0	0	0	103,029
2811	CRUDE PROD-COAL TAR-PET	6,139	0	0	0	6,139
2813	ALCOHOLS	0	109,411	0	0	109,411
2817	BENZENE AND TOLUENE	0	63,835	0	0	63,835
2871	NITROGEN CHEM FERTILIZER	0	171,837	0	43,414	215,251
2872	POTASSIC CHEM FERTILIZER	1,057	0	0	0	1,057
2911	GASOLINE, INCL NATURAL	0	710,928	0	631,715	1,342,643
2912	JET FUEL	0	81,283	0	47,024	128,307
2914	DISTILLATE FUEL OIL	0	412,051	0	732,663	1,144,714
2915	RESIDUAL FUEL OIL	0	342,789	0	752,708	1,095,497
2916	LUBRIC OILS-GREASES	0	172,626	0	11,122	183,748
2917	NAPHTHA, PETRLM SOLVENTS	0	6,253	0	0	6,253
2921	LIQUI PETR-COAL-NATR GAS	0	84	0	0	84
	Subzone Total :	31,769,138	2,842,363	10,503,466	2,218,646	47,333,613

Appendix O ZONE 15 Portland, OR

TABLE 3 Base Year (1987)
Vessel Transits by Subzone, Vessel Type, and Size.

Vessel Type	Large	Medium	Small	Total
Subzone : 1501A				
Passenger	0	6	0	6
Dry Cargo	1,137	2,838	2,460	6,435
Tanker	130	266	37	433
Dry Cargo Barge Tow	120	0	0	120
Tanker Barge Tow	13	0	0	13
Tug/Tow Boat	0	0	160	160
Subzone Total:	1,400	3,110	2,657	7,167
Subzone : 1502C				
Passenger	0	6	0	6
Dry Cargo	1,137	2,838	12,301	16,276
Tanker	130	266	37	433
Dry Cargo Barge Tow	120	0	13,870	13,990
Tanker Barge Tow	13	0	4,561	4,574
Tug/Tow Boat	0	0	26,594	26,594
Subzone Total:	1,400	3,110	57,363	61,873
Subzone : 1503F				
Passenger	0	6	14,328	14,334
Dry Cargo	1,087	2,511	12,225	15,823
Tanker	130	262	37	429
Dry Cargo Barge Tow	87	0	13,294	13,381
Tanker Barge Tow	13	0	4,343	4,356
Tug/Tow Boat	0	0	24,794	24,794
Subzone Total:	1,317	2,779	69,021	73,117

Note: Sum of all vessel transits within each study subzone.

7/22/91

Appendix O ZONE 15 Portland, OR

TABLE 3 Base Yeaı (19o7)
Vessel Transits by Suzone, Vessel Type, Size.

ZONE TOTALS

ZONE 15 Portland, OR

Vessel Type	Large	Medium	Small	Total
Passenger	0	6	14,328	14,334
Dry Cargo	1,137	2,838	12,301	16,276
Tanker	130	266	37	433
Dry Cargo Barge Tow	120	0	13,870	13,990
Tanker Barge Tow	13	0	4,561	4,574
Tug/Tow Boat	0	0	26,594	26,594
Zone Tota_:	1,400	3,110	71,691	76,201

Note: Sum of all arrivals/departures to/from all terminals within the Study Zone.

Appendix O Zone 15 Portland, OR

TABLE 4 Barges Per Tow - Average Factors by COE Waterway 8/6/91

COE Code	Waterway Name	Dry Barge	Tank Barge
SUBZONE	All Subzones within this Zone	1	1

NOTE: Average size of tows arriving/departing terminals within the waterway. Sizes of other tows transiting the area may differ.

Appendix O Zone 15 Portland, OR

TABLE 5 Other Local Vessels by Subzone *7/21/91*

Subzone	Name	Number of Vessels	Vessels per Square Mile
1501A		1,277	4.17
1502C		1,429	9.72
1503F		34,695	495.64
	Total for Zone	37,401	71.51

Note: State registered (1989/90) vessels estimated to be operated within the Subzone.

TABLE 6.1 Forecast 1995
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 1501A				
Passenger	0	6	0	6
Dry Cargo	3,175	6,143	57,313	66,631
Tanker	264	567	79	910
Dry Cargo Tow	0	0	16,273	16,273
Tanker Tow	0	0	5,337	5,337
Tug/Tow Boat	0	0	30,846	30,846
Subzone Total:	3,439	6,716	109,848	120,003
Subzone : 1502C				
Passenger	0	6	0	6
Dry Cargo	1,528	3,495	16,115	21,138
Tanker	140	293	40	473
Dry Cargo Tow	0	0	16,010	16,010
Tanker Tow	0	0	5,099	5,099
Tug/Tow Boat	0	0	31,058	31,058
Subzone Total:	1,668	3,794	68,322	73,784
Subzone : 1503F				
Passenger	0	6	15,037	15,043
Dry Cargo	1,466	3,118	16,016	20,600
Tanker	140	289	40	469
Dry Cargo Tow	0	0	15,349	15,349
Tanker Tow	0	0	4,855	4,855
Tug/Tow Boat	0	0	29,117	29,117
Subzone Total:	1,606	3,413	80,414	85,433

Note: Sum of all vessel transits within each study subzone.

Appendix O ZONE 15 Portland, OR 7/24/91

TABLE 6.2 Forecast 2000
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 1501A				
Passenger	0	7	0	7
Dry Cargo	3,840	7,108	67,591	78,539
Tanker	278	606	85	969
Dry Cargo Tow	0	0	17,801	17,801
Tanker Tow	0	0	5,714	5,714
Tug/Tow Boat	0	0	34,287	34,287
Subzone Total:	4,118	7,721	125,478	137,317
Subzone : 1502C				
Passenger	0	7	0	7
Dry Cargo	1,842	4,045	19,256	25,143
Tanker	149	317	44	510
Dry Cargo Tow	0	0	17,528	17,528
Tanker Tow	0	0	5,467	5,467
Tug/Tow Boat	0	0	34,505	34,505
Subzone Total:	1,991	4,369	76,800	83,160
Subzone : 1503F				
Passenger	0	7	15,780	15,787
Dry Cargo	1,771	3,629	19,138	24,538
Tanker	149	313	44	506
Dry Cargo Tow	0	0	16,808	16,808
Tanker Tow	0	0	5,205	5,205
Tug/Tow Boat	0	0	32,353	32,353
Subzone Total:	1,920	3,949	89,328	95,197

Note: Sum of all vessel transits within each study subzone.

Appendix O ZONE 15 Portland, OR

TABLE 6.3 Forecast 2005
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 1501A				
Passenger	0	7	0	7
Dry Cargo	4,653	8,312	80,487	93,452
Tanker	292	650	91	1,033
Dry Cargo Tow	0	0	19,489	19,489
Tanker Tow	0	0	6,113	6,113
Tug/Tow Boat	0	0	38,133	38,133
Subzone Total:	4,945	8,969	144,313	158,227
Subzone : 1502C				
Passenger	0	7	0	7
Dry Cargo	2,228	4,738	23,181	30,147
Tanker	158	344	47	549
Dry Cargo Tow	0	0	19,208	19,208
Tanker Tow	0	0	5,858	5,858
Tug/Tow Boat	0	0	38,356	38,356
Subzone Total:	2,386	5,089	86,650	94,125
Subzone : 1503F				
Passenger	0	7	16,308	16,315
Dry Cargo	2,144	4,266	23,040	29,450
Tanker	158	339	47	544
Dry Cargo Tow	0	0	18,424	18,424
Tanker Tow	0	0	5,577	5,577
Tug/Tow Boat	0	0	35,973	35,973
Subzone Total:	2,302	4,612	99,369	106,283

Note: Sum of all vessel transits within each study subzone.

Appendix O ZONE 15 Portland, OR

7/24/91

TABLE 6.4 Forecast 2010
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 1501A				
Passenger	0	7	0	7
Dry Cargo	5,650	9,784	96,201	111,635
Tanker	307	700	99	1,106
Dry Cargo Tow	0	0	21,355	21,355
Tanker Tow	0	0	6,539	6,539
Tug/Tow Boat	0	0	42,444	42,444
Subzone Total:	5,957	10,491	166,638	183,086
Subzone : 1502C				
Passenger	0	7	0	7
Dry Cargo	2,700	5,596	28,003	36,299
Tanker	168	377	53	598
Dry Cargo Tow	0	0	21,066	21,066
Tanker Tow	0	0	6,277	6,277
Tug/Tow Boat	0	0	42,670	42,670
Subzone Total:	2,868	5,980	98,069	106,917
Subzone : 1503F				
Passenger	0	7	16,853	16,860
Dry Cargo	2,600	5,047	27,834	35,481
Tanker	168	372	53	593
Dry Cargo Tow	0	0	20,213	20,213
Tanker Tow	0	0	5,976	5,976
Tug/Tow Boat	0	0	40,031	40,031
Subzone Total:	2,768	5,426	110,960	119,154

Note: Sum of all vessel transits within each study subzone.

Appendix O ZONE 15 Portland, OR

TABLE 6.5 Forecast 1995 - 2010 Vessel Transits by Vessel Type and Size

Vessel Type	Large	Medium	Small	Total
1995 FORECASTED ZONE TOTALS				
Passenger	0	6	15,037	15,043
Dry Cargo	1,378	3,201	14,634	19,213
Tanker	140	293	40	473
Dry Cargo Tow	0	0	16,010	16,010
Tanker Tow	0	0	5,099	5,099
Tug/Tow Boat	0	0	31,058	31,058
1995 Zone Total:	1,518	3,500	81,878	86,896
2000 FORECASTED ZONE TOTALS				
Passenger	0	7	15,780	15,787
Dry Cargo	1,557	3,506	16,448	21,511
Tanker	149	317	44	510
Dry Cargo Tow	0	0	17,528	17,528
Tanker Tow	0	0	5,467	5,467
Tug/Tow Boat	0	0	34,505	34,505
2000 Zone Total:	1,706	3,830	89,772	95,308
2005 FORECASTED ZONE TOTALS				
Passenger	0	7	16,308	16,315
Dry Cargo	1,883	3,990	19,143	25,016
Tanker	158	344	47	549
Dry Cargo Tow	0	0	19,208	19,208
Tanker Tow	0	0	5,858	5,858
Tug/Tow Boat	0	0	38,356	38,356
2005 Zone Total:	2,041	4,341	98,920	105,302
2010 FORECASTED ZONE TOTALS				
Passenger	0	7	16,853	16,860
Dry Cargo	2,283	4,710	23,081	30,074
Tanker	168	377	53	598
Dry Cargo Tow	0	0	21,066	21,066
Tanker Tow	0	0	6,277	6,277
Tug/Tow Boat	0	0	42,670	42,670
2010 Zone Total:	2,451	5,094	110,000	117,545

Note: Sum of all arrivals/departures to/from all terminals within the study zone.

TABLE 7 Vessel Casualty History (10 Year Totals) by Subzone, Vessel Type and Size, and Casualty Type

Vessel Type	Size	Collisions	Rammings	Groundings	Other	Total
Subzone: 1501A						
Passenger	Small	0	1	0	0	1
Dry Cargo	Large	1	0	0	0	1
Dry Cargo	Small	0	1	0	0	1
Tanker	Large	0	0	1	0	1
Fishing	Small	3	0	0	0	3
Subzone Totals:		4	2	1	0	7
Subzone: 1502C						
Dry Cargo	Large	1	2	7	0	10
Dry Cargo	Medium	0	0	1	0	1
Tanker	Large	1	0	0	0	1
Dry Cargo Barge Tow	Large	0	0	1	0	1
Dry Cargo Barge Tow	Small	2	1	1	0	4
Tanker Barge Tow	Small	2	0	0	0	2
Tug/Tow Boat	Small	0	0	1	0	1
Fishing	Small	1	0	2	0	3
Other	Small	2	0	1	0	3
Subzone Totals:		9	3	14	0	26
Subzone: 1503F						
Passenger	Small	0	0	1	0	1
Dry Cargo	Large	1	1	7	0	9
Dry Cargo	Small	0	1	0	0	1
Tanker	Large	0	1	2	0	3
Dry Cargo Barge Tow	Small	1	0	0	0	1
Tug/Tow Boat	Small	0	1	0	0	1
Fishing	Small	1	0	0	0	1
Subzone Totals:		3	4	10	0	17
Zone Totals:		16	9	25	0	50

Note: OTHER equals barge breakaways and weather caused vessel casualties.

APPENDIX TABLE O-8 ZONE 15, PORTLAND, OR - VTS
LEVELS IN OPERATION

(Not Applicable to This Sub-Zone.)

APPENDIX TABLE O-9 ZONE 15, PORTLAND, OR
CANDIDATE VTS DESIGN - 1995-2010

UNITS

0	Radar Module 1 - Average Performance
0	Radar Module 2 - Average Performance
1	Radar Module 3 - High Performance
0	Radar Module 4 - High Performance
0	Radar Module 5 - Special Purpose
0	Radar Module 6 - Special Purpose
0	ADS Module 7 - Active Radar Transponder (Type 1)
0	ADS Module 8 - Positional Transponder, Small Area, Very High Accuracy (Type 5)
0	ADS Module 9 - Positional Transponder, Small Area, High Accuracy (Type 6)
11	VHF Module 10 - Low power VHF Transmitting/ Receiving Facility
5	VHF Module 11 - High power VHF Transmitting/ Receiving Facility
0	Meteorological Module 12 - Air temperature, wind direction and speed
4	Meteorological Module 13 - Air temperature, wind direction and speed, visibility
0	Hydrological Module 14 - Water Temperature and Depth
0	Hydrological Module 15 - Water Temperature, Depth and Current
0	VHF/DF MODULE 16 - Line of position measurement to 2 degree RMS
0	CCTV MODULE 17 - Fixed Focus CCTV via Telephone Lines
0	CCTV MODULE 18 - Remotely Controllable CCTV via

TABLE 10A

Avoided Vessel Casualties 1996 - 2010
Candidate VTS Systems

7/31/91

Counts

Vessel Type	Size	Collision	Ramming	Grounding	Total
Passenger	Medium	.01	0.00	.02	.03
Passenger	Small	.21	.06	.12	.40
Dry Cargo	Large	1.63	.37	2.49	4.49
Dry Cargo	Medium	1.38	.29	.68	2.35
Dry Cargo	Small	2.00	.32	.43	2.75
Tanker	Large	.29	.09	.48	.86
Tanker	Medium	.08	.01	.06	.14
Tanker	Small	.00	0.00	.00	.01
Dry Cargo Barge T	Small	10.14	4.29	4.96	19.39
Tanker Barge Tow	Small	3.35	.82	2.76	6.92
Tug/Tow Boat	Small	1.95	.81	2.06	4.82
		21.04	7.06	14.06	42.16

Undiscounted Total Dollar Losses (1,000)

Vessel Type	Size	Collision	Ramming	Grounding	Total
Passenger	Medium	25	0	20	45
Passenger	Small	190	54	78	322
Dry Cargo	Large	2,438	742	814	3,993
Dry Cargo	Medium	2,217	622	213	3,052
Dry Cargo	Small	1,406	238	266	1,910
Tanker	Large	786	271	654	1,711
Tanker	Medium	121	18	32	171
Tanker	Small	3	0	1	4
Dry Cargo Barge T	Small	570	684	80	1,334
Tanker Barge Tow	Small	10,700	2,697	1,533	14,930
Tug/Tow Boat	Small	156	145	153	454
		18,610	5,472	3,845	27,926

Note: In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 11 Avoided Fatalities 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Medium	.00	0.00	.00	.00
Passenger	Small	.01	.00	.01	.03
Dry Cargo	Large	.20	.05	.31	.56
Dry Cargo	Medium	.17	.04	.09	.30
Dry Cargo	Small	.13	.02	.03	.18
Tanker	Small	.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	.02	.01	.01	.04
Tanker Barge Tow	Small	.01	.00	.01	.02
Tug/Tow Boat	Small	.00	.00	.00	.01
Totals		.55	.12	.46	1.13
Candidate VTS Design - Dollars					
Passenger	Medium	2,547.90	0.00	3,432.28	5,980.18
Passenger	Small	20,513.42	5,842.11	11,969.29	38,324.82
Dry Cargo	Large	306,175.04	69,351.07	469,273.34	844,799.46
Dry Cargo	Medium	258,737.94	55,204.11	128,684.51	442,626.56
Dry Cargo	Small	192,430.43	30,658.76	40,911.82	264,001.01
Tanker	Small	13.86	0.00	13.36	27.21
Dry Cargo Barge Tow	Small	33,520.29	14,189.55	16,385.82	64,095.66
Tanker Barge Tow	Small	10,851.45	2,703.98	9,108.23	22,663.65
Tug/Tow Boat	Small	6,455.35	2,682.04	6,798.67	15,936.05
Totals		831,245.67	180,631.62	686,577.31	1,698,454.61

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 12 Avoided Human Injuries 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Medium	.00	0.00	.00	.00
Passenger	Small	.16	.05	.09	.30
Dry Cargo	Large	.02	.00	.03	.06
Dry Cargo	Medium	.02	.00	.01	.03
Dry Cargo	Small	1.52	.24	.32	2.09
Tanker	Small	.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	.25	.10	.12	.47
Tanker Barge Tow	Small	.08	.02	.07	.17
Tug/Tow Boat	Small	.05	.02	.05	.12
Totals		2.10	.44	.70	3.24
Candidate VTS Design - Dollars					
Passenger	Medium	43.75	0.00	58.93	102.68
Passenger	Small	38,627.10	11,000.79	22,538.37	72,166.27
Dry Cargo	Large	5,256.95	1,190.74	8,057.30	14,504.99
Dry Cargo	Medium	4,442.46	947.84	2,209.48	7,599.78
Dry Cargo	Small	362,349.69	57,730.95	77,037.64	497,118.29
Tanker	Small	24.21	0.00	23.34	47.55
Dry Cargo Barge Tow	Small	58,570.48	24,793.59	28,631.18	111,995.25
Tanker Barge Tow	Small	18,904.05	4,724.70	15,914.93	39,543.68
Tug/Tow Boat	Small	11,279.52	4,686.36	11,879.41	27,845.29
Totals		499,498.21	105,074.98	166,350.58	770,923.77

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 13 Avoided Vessels Damaged 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Medium	.01	0.00	.01	.02
Passenger	Small	.18	.04	.04	.26
Dry Cargo	Large	1.21	.26	.24	1.71
Drv Cargo	Medium	1.02	.21	.07	1.29
Dry Cargo	Small	1.72	.22	.22	2.16
Tanker	Large	.22	.07	.06	.35
Tanker	Medium	.06	.01	.01	.07
Tanker	Small	.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	7.74	1.81	.69	10.24
Tanker Barge Tow	Small	2.56	.35	.38	3.29
Tug/Tow Boat	Small	.34	.09	.26	.69
Totals		15.05	3.06	1.98	20.09
Candidate VTS Design - Dollars					
Passenger	Medium	8,765.42	0.00	6,856.15	15,621.57
Passenger	Small	62,060.89	13,814.73	20,064.61	95,940.23
Dry Cargo	Large	889,915.56	192,904.62	144,512.41	1,227,332.58
Dry Cargo	Medium	908,539.36	185,509.21	29,628.07	1,123,676.65
Dry Cargo	Small	326,014.07	42,235.68	57,296.54	425,546.29
Tanker	Large	169,176.22	55,587.54	136,761.92	361,525.68
Tanker	Medium	38,192.09	5,082.96	13,585.01	56,860.07
Tanker	Small	274.62	0.00	345.27	619.88
Dry Cargo Barge Tow	Small	449,256.05	105,304.44	35,064.23	589,624.72
Tanker Barge Tow	Small	181,384.10	24,516.07	34,626.95	240,527.12
Tug/Tow Boat	Small	24,630.69	6,572.64	25,224.19	56,427.71
Totals		3,058,209.06	631,528.08	503,965.36	4,193,702.50

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 14 Avoided Cargo Damage/Loss 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Medium	.00	0.00	.00	.00
Passenger	Small	.04	.01	.01	.07
Dry Cargo	Large	.43	.13	.23	.79
Dry Cargo	Medium	.37	.10	.06	.53
Dry Cargo	Small	.64	.09	.09	.81
Tanker	Large	.08	.02	.05	.15
Tanker	Medium	.02	.00	.01	.03
Tanker	Small	.00	0.00	.00	.00
Dry Cargo Tow	Small	1.43	.60	.28	2.32
Tanker Tow	Small	.46	.12	.16	.73
Tug/Tow Boat	Small	.14	.05	.07	.25
Totals		3.61	1.12	.95	5.68
Candidate VTS Design - Dollars					
Passenger	Medium	38.56	0.00	21.34	59.90
Passenger	Small	156.95	34.94	45.31	237.20
Dry Cargo	Large	4,581.76	1,470.34	664.07	6,716.16
Dry Cargo	Medium	3,871.88	1,170.40	182.10	5,224.39
Dry Cargo	Small	1,479.54	191.68	257.20	1,928.42
Tanker	Large	2,692.59	850.13	3,215.98	6,758.70
Tanker	Medium	280.60	36.88	64.98	382.46
Tanker	Small	3.68	0.00	2.17	5.85
Tanker Tow	Small	46,428.98	11,627.24	15,706.33	73,762.55
Tug/Tow Boat	Small	296.49	79.12	295.56	671.16
Totals		59,831.03	15,460.72	20,455.04	95,746.79

Note1: Dollar values include bulk petroleum and chemical cargos only and all vessel fuels spilled. Dollar values exclude cargo loss/damage for non-tank vessel types.

Note2: In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts total were calculated before rounding.

TABLE 15 Avoided NavAid Damage 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Small	0.00	.01	.00	.01
Dry Cargo	Large	0.00	.04	.01	.06
Dry Cargo	Medium	0.00	.03	.00	.04
Dry Cargo	Small	0.00	.04	.00	.04
Tanker	Large	0.00	.01	.00	.01
Tanker	Medium	0.00	.00	.00	.00
Tanker	Small	0.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	0.00	.49	.03	.52
Tanker Barge Tow	Small	0.00	.09	.02	.11
Tug/Tow Boat	Small	0.00	.09	.01	.10
Totals		0.00	.81	.08	.89
Candidate VTS Design - Dollars					
Passenger	Small	0.00	39.28	4.03	43.31
Dry Cargo	Large	0.00	237.99	80.62	318.61
Dry Cargo	Medium	0.00	189.45	22.11	211.55
Dry Cargo	Small	0.00	206.12	13.77	219.89
Tanker	Large	0.00	57.07	15.65	72.72
Tanker	Medium	0.00	6.20	1.86	8.06
Tanker	Small	0.00	0.00	.13	.13
Dry Cargo Barge Tow	Small	0.00	2,771.01	160.19	2,931.20
Tanker Barge Tow	Small	0.00	528.05	87.04	615.09
Tug/Tow Boat	Small	0.00	523.76	66.47	590.23
Totals		0.00	4,558.92	451.87	5,010.80

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 16 Avoided Bridge Damage 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Small	.00	.00	0.00	.00
Dry Cargo	Large	0.00	.04	0.00	.04
Dry Cargo	Medium	0.00	.03	0.00	.03
Dry Cargo	Small	.00	.02	0.00	.02
Tanker	Large	0.00	.01	0.00	.01
Tanker	Medium	0.00	.00	0.00	.00
Tanker	Small	.00	0.00	0.00	.00
Dry Cargo Barge Tow	Small	.01	.27	0.00	.28
Tanker Barge Tow	Small	.00	.05	0.00	.06
Tug/Tow Boat	Small	.00	.05	0.00	.05
Totals		.02	.48	0.00	.50
Candidate VTS Design - Dollars					
Passenger	Small	594.36	7,611.14	0.00	8,205.50
Dry Cargo	Large	0.00	82,282.76	0.00	82,282.76
Dry Cargo	Medium	0.00	65,393.05	0.00	65,393.05
Dry Cargo	Small	5,510.03	39,554.20	0.00	45,064.23
Tanker	Large	0.00	19,747.68	0.00	19,747.68
Tanker	Medium	0.00	2,143.97	0.00	2,143.97
Tanker	Small	11.01	0.00	0.00	11.01
Dry Cargo Barge Tow	Small	28,211.52	536,972.90	0.00	565,184.42
Tanker Barge Tow	Small	9,323.14	102,326.20	0.00	111,649.33
Tug/Tow Boat	Small	5,374.18	100,400.12	0.00	105,774.31
Totals		49,024.25	956,432.01	0.00	1,005,456.25

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

Appendix O Zone 15 Portland, OR
TABLE 17 Avoided Hazardous Commodity Spills 1996 - 2010 7/30/91

Commodity	Catastrophic	Large	Medium	Small	Total
Candidate Vts Design - Counts					
BENZENE AND TOLUENE	0.00	.00	.00	.01	.01
ALCOHOLS	0.00	.00	.00	.01	.02
JET FUEL	.00	.00	.01	.00	.01
CRUDE PETROLEUM	.00	.00	.00	.00	.01
GASOLINE, INCL NATURAL	.01	.05	.12	.00	.17
DISTILLATE FUEL OIL	.01	.05	.14	.68	.88
RESIDUAL FUEL OIL	.01	.06	.41	.65	1.13
	.02	.16	.69	1.35	2.23

Note: In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

Zone 15 Portland, OR
Annual Benefit & Cost Streams
Candidate VTS Systems

7/31/91

Discounted to 1993

Year	Investment ($1,000)	Operation & Maintenance ($1,000)	Benefits ($1,000)
1993	5,687	0	0
1996	0	473	1,281
1997	0	430	1,185
1998	0	391	1,095
1999	0	356	1,011
2000	0	323	941
2001	0	294	867
2002	0	267	804
2003	0	243	746
2004	0	221	691
2005	0	201	644
2006	0	182	595
2007	0	166	553
2008	0	151	514
2009	0	137	477
2010	0	125	446
	5,687	3,960	11,850

Undiscounted

Year	Investment ($1,000)	Operation & Maintenance ($1,000)	Benefits ($1,000)
1993	5,687	0	0
1996	0	601	1,628
1997	0	601	1,655
1998	0	601	1,683
1999	0	601	1,710
2000	0	601	1,750
2001	0	601	1,774
2002	0	601	1,810
2003	0	601	1,846
2004	0	601	1,882
2005	0	601	1,931
2006	0	601	1,962
2007	0	601	2,005
2008	0	601	2,049
2009	0	601	2,093
2010	0	601	2,150
	5,687	9,020	27,926

APPENDIX O

ZONE 15 - PORTLAND, OR

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Portland, Oregon		(Port 15)		Wildlife Abundance Tables Fish & Shellfish Grams per Square Meter			
Port & Subzone	Species Category	Species Code	Species Name	Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
1501	101	1	American Shad	.1118	.1118	.1118	.1118
1501	101	78	Sockeye Salmon	0.0000	.1300	0.0000	0.0000
1501	101	79	Chum Salmon	0.0000	.0300	.3000	0.0000
1501	101	80	Pink Salmon	.2500	.2500	.2500	0.0000
1501	101	81	Chinook Salmon	.0042	.0042	.0042	.0042
1501	101	81	King Salmon	.0840	.0510	.0180	.2200
1501	101	82	Coho Salmon	0.0000	.3200	.3200	0.0000
1501	102	84	Jack Mackerel	.2170	.2170	.2170	.2170
1501	102	85	Pacific Anchovy	.0005	.0005	.0005	.0005
1501	102	86	Pacific Herring	.1715	.1715	.1715	.1715
1501	102	97	Walleye Pollock	.0033	.0033	.0033	.0033
1501	102	217	Box Crab	.0039	.0039	.0039	.0039
1501	104	14	Thresher Shark	.0128	.0128	.0128	.0128
1501	104	15	Spiny Dogfish	.1626	.1626	.1626	.1626
1501	105	88	Pacific Halibut	.0604	.0604	.0604	.0604
1501	105	100	Arrowtooth Flounder	.0760	.0760	.0760	.0760
1501	105	104	Starry Flounder	.0073	.0073	.0073	.0073
1501	105	106	Dover Sole	.2461	.2461	.2461	.2461
1501	105	107	English Sole	.2297	.2297	.2297	.2297
1501	105	108	Rock Sole	.0039	.0039	.0039	.0039
1501	105	113	Pacific Sanddab	.3012	.3012	.3012	.3012
1501	105	115	Pacific Tomcod	.0978	.0978	.0978	.0978
1501	105	117	Spotted Ratfish	.0262	.0262	.0262	.0262
1501	105	140	Slender Sole	.0251	.0251	.0251	.0251
1501	105	141	Flathead Sole	.0051	.0051	.0051	.0051
1501	105	242	Petral Sole	.0550	.0550	.0550	.0550
1501	105	250	Rex Sole	.3020	.3020	.3020	.3020
1501	106	89	Pacific Ocean Perch	.0027	.0027	.0027	.0027
1501	106	90	Bocaccio	.0244	.0244	.0244	.0244
1501	106	90	Cannery Rockfish	.3221	.3221	.3221	.3221
1501	106	90	Dark Blotched Rockfish	.0962	.0962	.0962	.0962
1501	106	90	Greenstripe Rockfish	.0673	.0673	.0673	.0673
1501	106	90	Pygmy Rockfish	.0352	.0352	.0352	.0352
1501	106	90	Red Striped Rockfish	.1357	.1357	.1357	.1357
1501	106	90	Sharpchin Rockfish	.2677	.2677	.2677	.2677
1501	106	90	Silvergrey Rockfish	.0160	.0160	.0160	.0160
1501	106	90	Widow Rockfish	.0489	.0489	.0489	.0489
1501	106	90	Yelloweye Rockfish	.0190	.0190	.0190	.0190
1501	106	90	Yellowtail Rockfish	.3527	.3527	.3527	.3527
1501	106	91	Perch	.0270	.0270	.0270	.0270
1501	106	92	Sablefish	.9746	.9746	.9746	.9746
1501	106	93	Pacific Cod	.0084	.0084	.0084	.0084
1501	106	94	Lingcod	.3005	.3005	.3005	.3005
1501	106	95	Pacific Herring	2.7546	2.7546	2.7546	2.7546
1501	106	116	Big Skate	.0723	.0723	.0723	.0723
1501	106	116	Longnose Skate	.0248	.0248	.0248	.0248
1501	106	118	Greenlings	.0007	.0007	.0007	.0007
1501	107	233	Pacific Sea Scallop	.0240	.0240	.0240	.0240
1501	107	299	Sea Urchin	.0246	.0246	.0246	.0246
1501	107	299	Sponge	.0302	.0302	.0302	.0302
1501	107	299	Weathervane Scallop	.0015	.0015	.0015	.0015
1501	108	221	Dungeness Crab	.0164	.0164	.0164	.0164
1501	108	222	Shrimp	.5800	.5800	.5800	.5800
1501	109	223	Market Squid	.0020	.0020	.0020	.0020

APPENDIX O

ZONE 15 - PORTLAND, OR (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Portland, Oregon (Port 15)

Wildlife Abundance Tables
Fish & Shellfish
Grams per Square Meter

Port & Subzone	Species Category	Species Code	Species Name	Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
1501	109	223	Squid	.0710	.0710	.0710	.0710
1502	101	78	Sockeye	0.0000	16.7000	0.0000	0.0000
1502	101	79	Chum	0.0000	1.2000	11.5000	0.0000
1502	101	81	Chinook	4.0000	2.4000	.8500	10.6000
1502	101	82	Coho	0.0000	6.1000	6.1000	0.0000
1502	102	86	Herring	1.5000	1.5000	0.0000	0.0000
1502	102	103	Smelt	.1000	.1000	.1000	.1000
1502	103	9	Striped Bass	.4300	.4300	.4300	.4300
1502	104	14	Sharks	5.5000	5.5000	5.5000	5.5000
1502	105	5	Butter Sole	.0070	.0070	.0070	.0070
1502	105	88	Pacific Halibut	.0120	.0120	.0120	.0120
1502	105	100	Arrowtooth Flounder	.0420	.0420	.0420	.0420
1502	105	104	Starry Flounder	1.2000	.0790	1.5000	1.2000
1502	105	106	Dover Sole	.1200	.1200	.1200	.1200
1502	105	107	English Sole	1.7000	1.7000	1.7000	1.7000
1502	105	108	Rock Sole	.3000	.3000	.3000	.3000
1502	105	109	Sole	.3600	.3600	.3600	.3600
1502	106	90	Rockfish	.3900	.3900	.3900	.3900
1502	106	91	Perch	.2600	.2600	.2600	.2600
1502	106	92	Sablefish	.0190	.0190	.0190	.0190
1502	106	93	Cod	5.9000	2.9000	2.9000	5.9000
1502	106	94	Lingcod	.3600	.3600	.3600	.3600
1502	106	95	Pacific Hake	14.8000	0.0000	14.8000	14.8000
1502	107	211	Soft Clam	.3100	.3100	.3100	.3100
1502	107	211	Soft Clam	.3400	.3400	.3400	.3400
1502	107	226	Butter Clam	.1100	.1100	.1100	.1100
1502	107	227	Horse Clam	.1000	.1000	.1000	.1000
1502	107	228	Geoduc	2.5000	2.5000	2.5000	2.5000
1502	107	229	Manila Clam	1.4000	1.4000	1.4000	1.4000
1502	107	230	Pacific Oyster	2.2000	2.2000	2.2000	2.2000
1502	107	231	Olympic Oyster	.0013	.0013	.0013	.0013
1502	108	221	Dungeness Crab	2.3000	2.3000	2.3000	2.3000
1502	108	222	Pacific Shrimp	.1700	.1700	.1700	.1700
1503	101	78	Sockeye	0.0000	16.7000	0.0000	0.0000
1503	101	79	Chum	0.0000	1.2000	11.5000	0.0000
1503	101	81	Chinook	4.0000	2.4000	.8500	10.6000
1503	101	82	Coho	0.0000	6.1000	6.1000	0.0000
1503	102	86	Herring	1.5000	1.5000	0.0000	0.0000
1503	102	103	Smelt	.1000	.1000	.1000	.1000
1503	103	9	Striped Bass	.4300	.4300	.4300	.4300
1503	104	14	Sharks	5.5000	5.5000	5.5000	5.5000
1503	105	5	Butter Sole	.0070	.0070	.0070	.0070
1503	105	88	Pacific Halibut	.0120	.0120	.0120	.0120
1503	105	100	Arrowtooth Flounder	.0420	.0420	.0420	.0420
1503	105	104	Starry Flounder	1.2000	.0790	1.5000	1.2000
1503	105	106	Dover Sole	.1200	.1200	.1200	.1200
1503	105	107	English Sole	1.7000	1.7000	1.7000	1.7000
1503	105	108	Rock Sole	.3000	.3000	.3000	.3000
1503	105	109	Sole	.3600	.3600	.3600	.3600
1503	106	90	Rockfish	.3900	.3900	.3900	.3900
1503	106	91	Perch	.2600	.2600	.2600	.2600
1503	106	92	Sablefish	.0190	.0190	.0190	.0190
1503	106	93	Cod	5.9000	2.9000	2.9000	5.9000

APPENDIX O

ZONE 15 - PORTLAND, OR (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Wildlife Abundance Tables
Fish & Shellfish
Grams per Square Meter

Portland, Oregon Port & Subzone	Species Category	(Port 15) Species Code	Species Name	Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
1503	106	94	Lingcod	.3600	.3600	.3600	.3600
1503	106	95	Pacific Hake	14.8000	0.0000	14.8000	14.8000
1503	107	211	Soft Clam	.3100	.3100	.3100	.3100
1503	107	211	Soft Clam	.3400	.3400	.3400	.3400
1503	107	226	Butter Clam	.1100	.1100	.1100	.1100
1503	107	227	Horse Clam	.1000	.1000	.1000	.1000
1503	107	228	Geoduc	2.5000	2.5000	2.5000	2.5000
1503	107	229	Manila Clam	1.4000	1.4000	1.4000	1.4000
1503	107	230	Pacific Oyster	2.2000	2.2000	2.2000	2.2000
1503	107	231	Olympic Oyster	.0013	.0013	.0013	.0013
1503	108	221	Dungeness Crab	2.3000	2.3000	2.3000	2.3000
1503	108	222	Pacific Shrimp	.1700	.1700	.1700	.1700

APPENDIX O

ZONE 15 - PORTLAND, OR (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Portland, Oregon Port & Subzone	Species Category	(Port 15) Species Code	Species Name	Wildlife Abundance Tables Fish & Shellfish Larvae Numbers per Square Meter Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
1501	202	1085	Pacific Anchovy	.0100	0.0000	0.0000	0.0000
1501	202	1086	Pacific Herring	.0500	0.0000	0.0000	0.0000
1501	202	1110	Sandlance	.1900	0.0000	0.0000	0.0000
1501	202	1121	Blenny	.0023	0.0000	0.0000	0.0000
1501	202	1249	Guillfish	.0079	0.0000	0.0000	0.0000
1501	205	1103	Butter sole	.9740	0.0000	0.0000	1.0372
1501	205	1104	Starry Flounder	.2375	0.0000	0.0000	.1466
1501	205	1106	Dover Sole	.0070	.0070	0.0000	.0070
1501	205	1108	Rock Sole	.0095	0.0000	0.0000	0.0000
1501	205	1137	Sand Sole	.1580	0.0000	0.0000	.4820
1501	205	1137	Sand Sole	.2300	0.0000	0.0000	0.0000
1501	205	1140	Slender Sole	.0700	0.0000	0.0000	0.0000
1501	205	1141	Flathead	.0195	0.0000	0.0000	0.0000
1501	205	1250	Rex Sole	.0200	0.0000	0.0000	0.0000
1501	206	1089	Perch	.1300	0.0000	0.0000	0.0000
1501	206	1092	Sablefish	.0067	0.0000	0.0000	0.0000
1501	206	1093	Lingcod	.0400	0.0000	0.0000	0.0000
1501	206	1095	Hake	.4200	0.0000	0.0000	0.0000
1501	206	1103	Smelts	4.1400	0.0000	0.0000	0.0000
1501	206	1109	Sculpin	.6200	0.0000	0.0000	0.0000
1501	206	1111	Poachers	.0400	0.0000	0.0000	0.0000
1501	206	1112	Lumpfish	.0600	0.0000	0.0000	0.0000
1501	206	1114	Gunnel	.0600	0.0000	0.0000	0.0000
1501	206	1120	Goby	.0100	0.0000	0.0000	0.0000
1501	206	1245	Lanternfish	.0500	0.0000	0.0000	0.0000
1501	206	1247	Ronquil	.0300	0.0000	0.0000	0.0000
1501	206	1248	Prickleback	.0700	0.0000	0.0000	0.0000
1501	207	1199	Larvae	.0002	.0002	.0002	0.0000
1501	208	1199	Larvae	.0160	.0420	0.0000	0.0000
1502	202	1199	Larvae	19.5000	84.6000	84.6000	22.8000
1502	205	1199	Larvae	54.5000	32.7000	17.8000	.2000
1502	206	1199	Larvae	.2700	4.6000	10.1000	.2000
1502	207	1199	Larvae	.0095	.0950	.0095	0.0000
1502	208	1199	Larvae	.1600	.4200	0.0000	0.0000
1503	202	1199	Larvae	19.5000	84.6000	84.6000	22.8000
1503	205	1199	Larvae	54.5000	32.7000	17.8000	.2000
1503	206	1199	Larvae	.2700	4.6000	10.1000	.2000
1503	207	1199	Larvae	.0095	.0950	.0095	0.0000
1503	208	1199	Larvae	.1600	.4200	0.0000	0.0000

APPENDIX O

ZONE 15 - PORTLAND, OR (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Portland, Oregon		(Port 15)		Wildlife Abundance Tables Birds Numbers per Square Kilometer			
Port & Subzone	Species Category	Species Code	Species Name	Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
1501	111	511	Ducks	9.0000	0.0000	9.0000	18.0000
1501	111	512	Coots	2.3000	0.0000	2.3000	4.6000
1501	111	513	Geese	13.5000	0.0000	13.5000	27.0000
1501	111	514	Swans	.6500	0.0000	.6500	1.3000
1501	112	570	Shorebirds	321.0000	217.0000	306.0000	368.0000
1501	113	530	Seabirds	37.0000	37.0000	37.0000	37.0000
1502	111	511	Ducks	9.0000	0.0000	9.0000	18.0000
1502	111	512	Coots	2.3000	0.0000	2.3000	4.6000
1502	111	513	Geese	13.5000	0.0000	13.5000	27.0000
1502	111	514	Swans	.6500	0.0000	.6500	1.3000
1502	112	570	Shorebirds	321.0000	217.0000	306.0000	368.0000
1503	111	511	Ducks	9.0000	0.0000	9.0000	18.0000
1503	111	512	Coots	2.3000	0.0000	2.3000	4.6000
1503	111	513	Geese	13.5000	0.0000	13.5000	27.0000
1503	111	514	Swans	.6500	0.0000	.6500	1.3000
1503	112	570	Shorebirds	321.0000	217.0000	306.0000	368.0000

APPENDIX P

ANCHORAGE/COOK INLET, AK

(ZONE 16)

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MAPS

ZONE SPECIFIC TABLES

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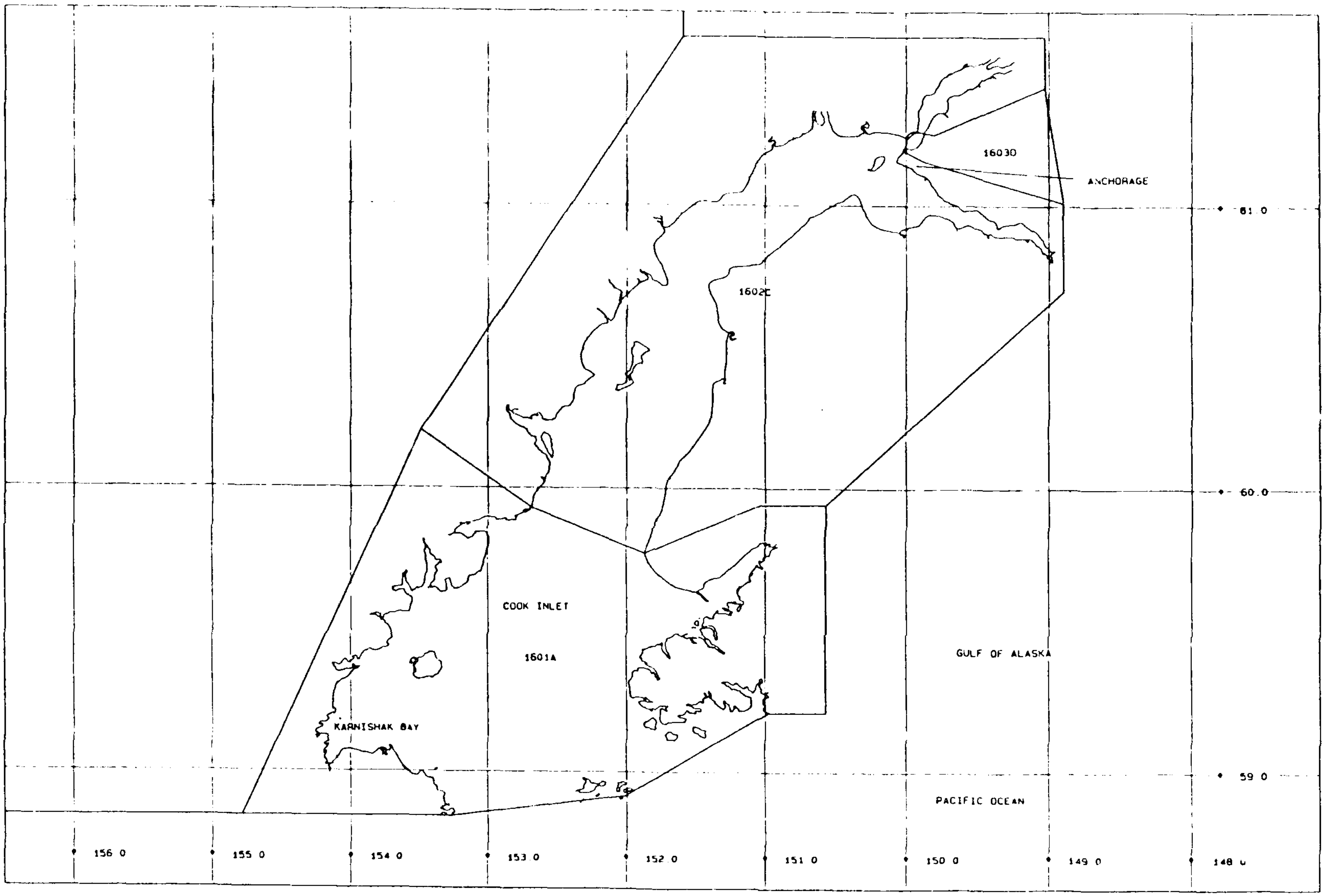
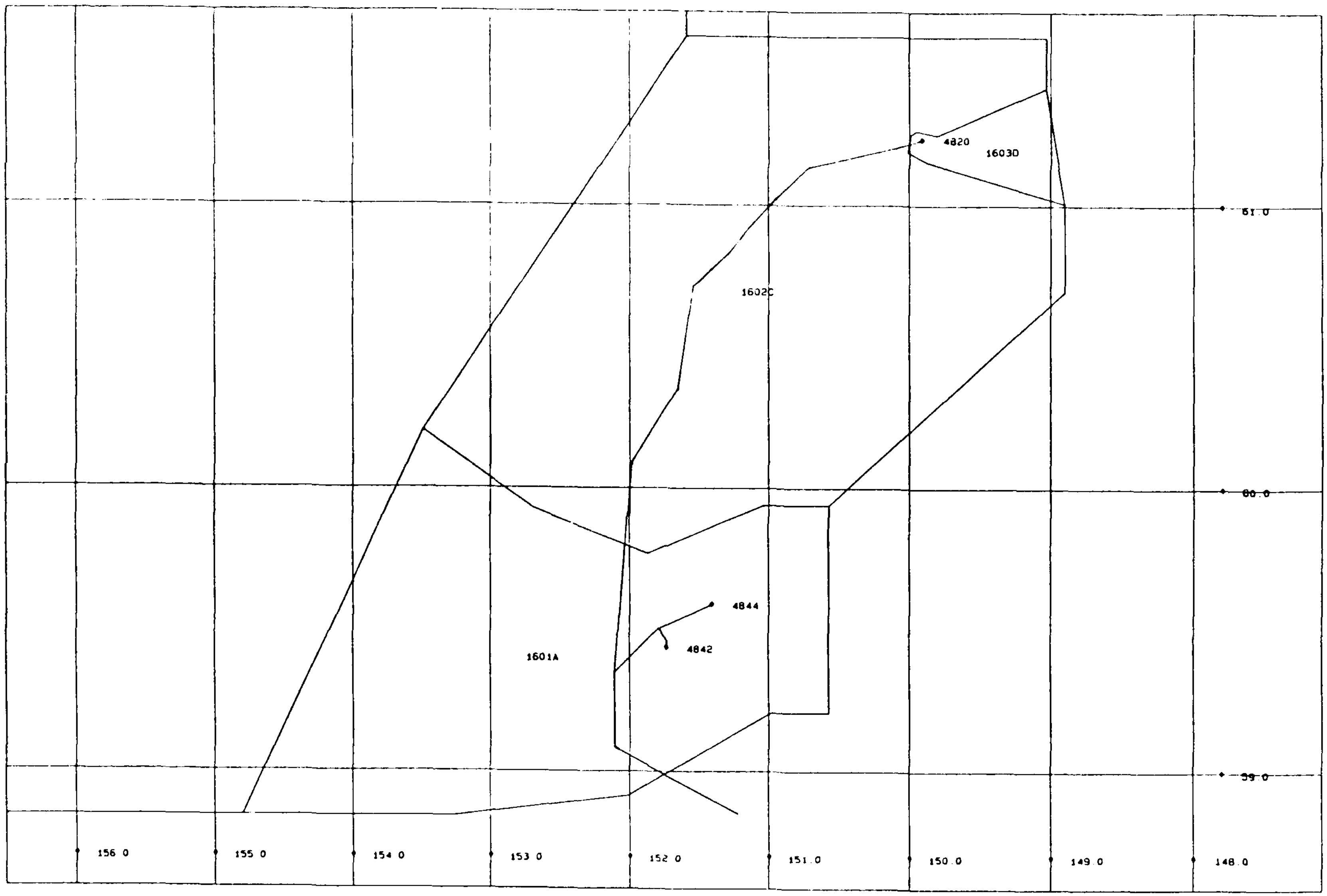
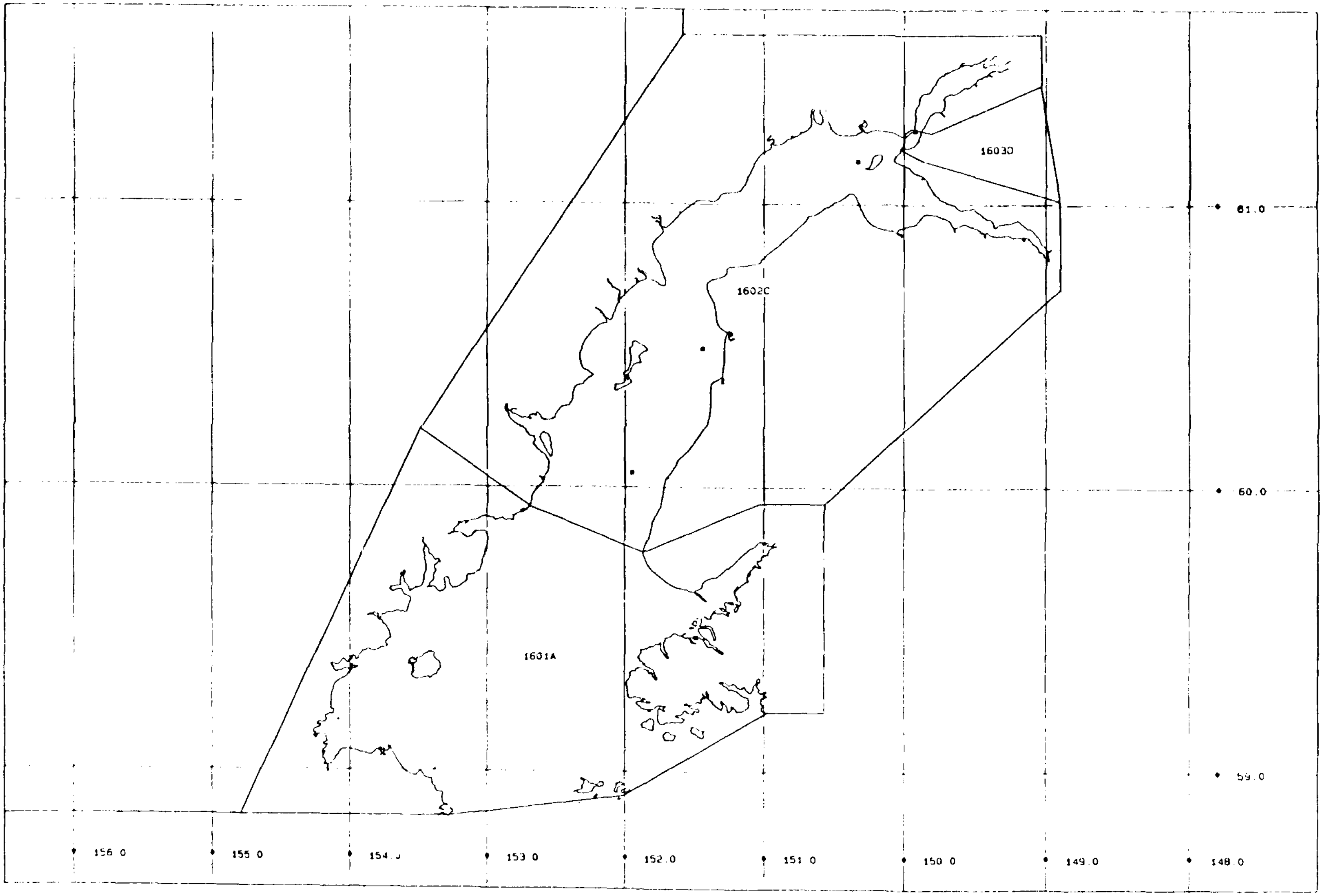
STUDY ZONE MAPS



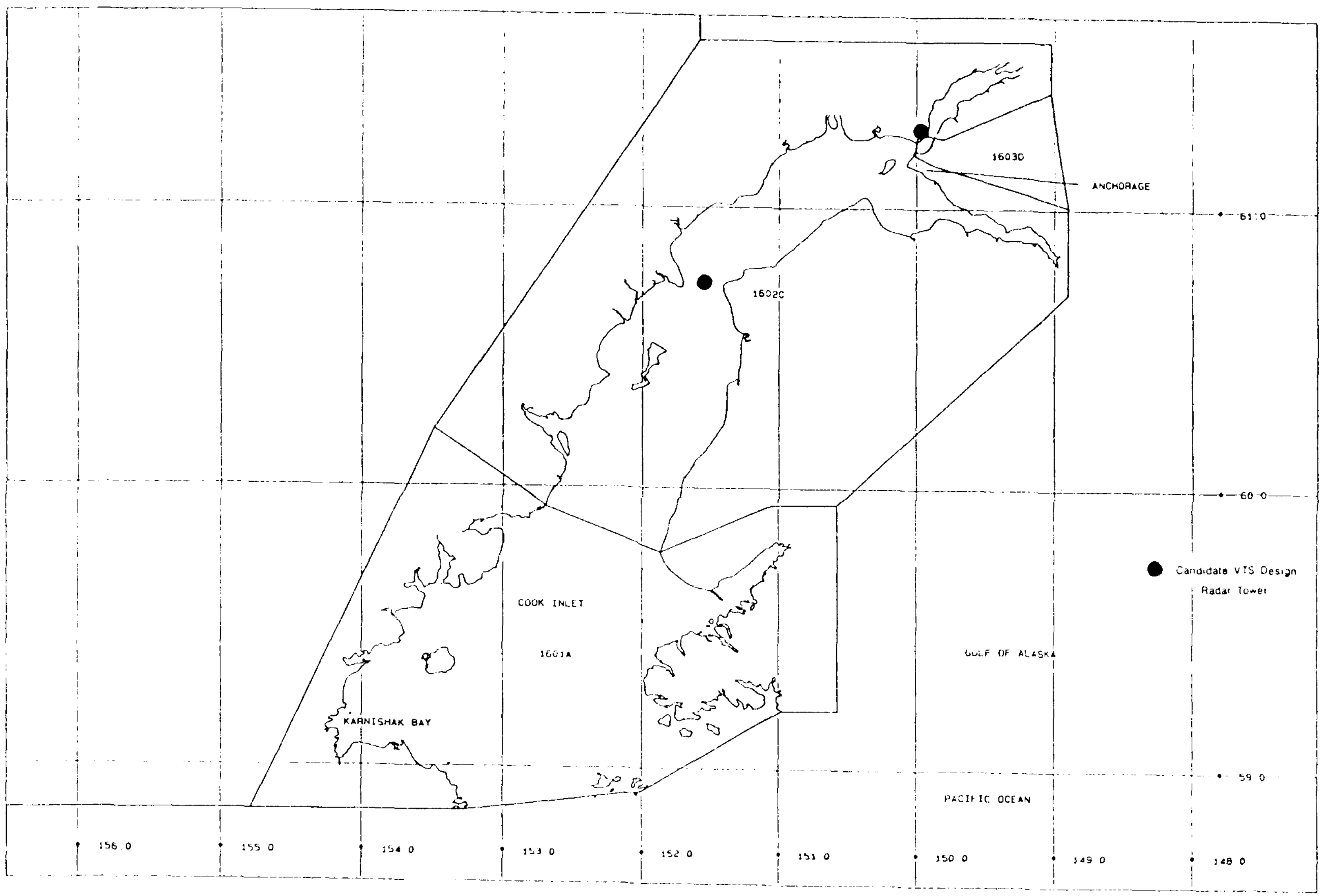
ZONE 16 - ANCHORAGE/COOK INLET, AK - ZONE AND SUBZONE BOUNDARIES



ZONE 16 - ANCHORAGE/COOK INLET, AK - DOMINANT VESSEL ROUTES AND COE WATERWAY CODES



ZONE 16 - ANCHORAGE/COOK INLET, AK - BASE PERIOD (10 YEAR) VESSEL CASUALTIES



ZONE 16 - ANCHORAGE/COOK INLET, AK - CANDIDATE VTS DESIGN RADAR LOCATIONS

CANDIDATE VTS DESIGN REPORT

FOR

ANCHORAGE/COOK INLET, AK

(ZONE 16)

Prepared for:
U.S. Department of Transportation
Research and Special Programs Administration
John A. Volpe National Transportation Systems Center
Cambridge, MA 02142

Prepared by:
NAVCOM Systems, Inc.,
7203 Gateway Court
Manassas, VA 22110

July 1991

OVERVIEW

The Candidate VTS Design described in this appendix is one of 23 developed for all the study zones included in the study. This appendix documents the task performed, under Contract DTRS-57-88-C-00088 Technical Task Directive 13, as an integral part of the total Port Needs Study. The ultimate product of this task effort is an informed preliminary technical assessment of the approximate cost to the Federal Government to implement and operate a state-of-the-art VTS system. This appendix does not contain a comprehensive definition of the VTS operating requirements nor does it propose a final VTS specification suitable for implementation.

In order to consistently estimate the life cycle costs of a VTS system in each of the study zones, a "Candidate VTS Design" has been defined for each study zone using a uniform set of design criteria. Each study zone Candidate VTS Design is a composite of generic modules selected from a master list of 18 state-of-the-art surveillance modules, communications and display technology. Among the surveillance modules in the master list are several levels of technical performance from which the selection is made for application to each study subzone to address the local navigational surveillance needs and conditions. The Candidate VTS Design in each study zone represents a consistent application of the surveillance modules at the subzone level. The subzone surveillance technology is subsequently integrated into a total system for the study zone via state-of-the-art communications and display consoles at the Vessel Traffic Center (VTC) in each zone.

The application of the surveillance modules in each subzone responds to the technical requirements of that subzone as perceived by the study team. The Candidate VTS Design represents a preliminary engineering judgement on the appropriate level of technology in each subzone. The Candidate VTS Design may be considered as an informed judgement made by the contractor study team for the sole purpose of developing cost estimates that are consistent across the 23 study zones and suitable for benefit/cost comparisons among the study zones and initial budget planning and implementation priorities. The approach used to calculate VTS system costs for all 23 study zones is found in Volume III, Technical Supplement.

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COOK INLET, ALASKA VTS DESIGN

1.0 SCOPE

This report includes a port survey and a VTS design for Cook Inlet, Alaska. The port survey is based on a review of all pertinent literature including navigational charts. The methodology used to produce the VTS design entails coupling the problems identified in the port survey with solutions offered by state-of-the-art technology as identified in the VTS Technology Survey, November 1990. When possible, technological advances which permit manpower reductions are applied. Not all VTS problems are amenable to strictly technological solutions; some require changes in procedures and/or enforcement. These situations are identified where they occur.

2.0 COOK INLET SURVEY

2.1 INTRODUCTION

This survey report is based exclusively upon review of available literature and examination of the charts for the surveyed area and its approaches. The information thus gained has been evaluated and interpreted based upon the Survey Team's experience as professional mariners and in vessel traffic management systems.

The surveyed area includes all of Cook Inlet from its three seaward entrances to the head of deep water navigation at Anchorage. In terms of commercial significance, Anchorage, the Drift River and Kenai/Nikiski are the major ports studied. The waterway extends 175 miles from the entrances of Cook Inlet to Anchorage, and is over 60 miles wide at its broadest expanse. In addition to shipping, Cook Inlet supports offshore oil production/ exploration and major fisheries.

Vessel traffic density is fortuitously low. An extreme tidal range, strong currents and uncertain hydrography combine with limited aids to navigation and the presence of offshore oil platforms to make navigation challenging enough without other shipping to contend with. Vessel Traffic Services (VTS) requirements clearly must address navigational assistance as well as traffic advice, where needed.

The ecosystem is sensitive to the effects of pollution, with major local concern apparently centered upon protection of the fisheries, most notably salmon. The potential of conflicts between primary users of the waterway is high, and adversarial relationships have developed between offshore oil interests, commercial shipping and fishermen. Public concern with the safe movement of ships, particularly those carrying pollutants, has been focused by the <u>EXXON VALDEZ</u> incident.

2.2 OVERVIEW OF THE PORT

Climate within the Survey Area varies considerably. The coastal region's sub-arctic maritime conditions are moderated by the influence of the Japan Current, and temperature extremes are much smaller along the outer coast than at Anchorage, near the head of Cook Inlet. During winter months temperatures at the entrance and in lower Cook Inlet range from average highs in the low twenties (0 Fahrenheit) to average nighttime lows of 5^0 F. Anchorage, by contrast, experiences much lower minimum temperatures (Reference 1).

All of Cook Inlet is subject to extended periods of low visibility, with Anchorage averaging 33+ days per year and visibility less than 0.5 mile. In addition to foggy conditions, the entrance is subject to periods of low visibility caused by heavy precipitation. (Average rainfall exceeds 60" per year). Toward the head of navigation, average rainfall is only 7" per year.

Winds near the coast are only slightly less variable than over the open Gulf of Alaska. Because of the rugged shoreline near the entrance, there are strong local effects in both velocity and direction. Anchorage experiences gale force winds less than one percent of the time, with 20-40% calm during the winter months. This is misleading, because strong gales with gusts to 60 knots or better occur about once per month between late fall and spring.

The diurnal range of tide in Cook Inlet varies from 14.3 feet at Port Chatham to 29.0 feet at Anchorage. At the entrance, tidal current velocities are two to three knots and are higher at some locations within Cook Inlet itself.

The geological characteristics of Cook Inlet reveal its glacial origin. The shores are strewn by boulders, some of great size, and soundings reveal the presence underwater of similar boulders, particularly in areas with hard bottom where they have not been covered by silt. The boulders can rise as much as 30 feet above the charted depth and may be moved by winter ice. Mariners are advised to avoid areas where the depths at low tide are less than 30 feet plus the vessel's draft. Water within the inlet tends to be discolored by glacial silt, and sufficient sediment is entrained to be damaging to ships' shaft bearings and salt water pumps.

The 1972 COLREGS apply throughout.

Pilotage, except for certain exempted vessels, is compulsory for all vessels navigating the inland waters of Alaska. The state-established boundary line for Alaskan waters is a line drawn from Cape Douglas through Cape Elizabeth Light to the Kenai Peninsula shoreline. Ships moving between the Cook Inlet entrance and the

Homer Pilot Station are excluded from compulsory use of pilots, however.

Vessels exempted from the pilotage requirement are:

Fishing vessels registered in the United States or British Columbia.

Vessels under enrollment.

Motorboats, as defined by the Federal Motor Boat Act of 1940.

U. S. registered vessels of less than 300 Gross Tons (GT).

Towboats of U. S. registry and vessels owned by the Sate of Alaska which are engaged exclusively on the rivers of Alaska or in the coastwise trade on the West Coast of the U. S., including Alaska, Hawaii and British Columbia.

Under certain conditions vessels of Canada, including cruise ships, engaged in frequent trade between British Columbia and Alaska.

The Southwest Alaska Pilots Association provides pilotage for all Cook Inlet ports and maintain an office at Homer. The office maintains continuous watch on VHF-FM Channels 10 and 16, and on 8294.2 kHz from 0800-1200, and on 4125.0 kHz from 1300-1700 weekdays. The Cook Inlet pilot boat guards Channels 10 and 16 while underway. The established Pilot Boarding Area is about one mile south of Homer Spit Light (about 143 miles from Anchorage).

Offshore drilling and exploration activities are increasing in Cook Inlet, with a number of platforms presently in operation primarily in its northern half. Above Anchor Point there are extensive shoal areas, most of which are poorly marked. Some shifting of the shoals occurs as the result of current and deposit of silt, and shoal areas are subject to often unpredictable tide rips and swirls.

Cook Inlet is adequately marked by fixed aids to navigation but these may be obscured during periods of low visibility. Buoys are sensitive to dislocation during the winter months by moving ice and may be withdrawn or replaced with unlighted aids if winter conditions warrant. At other times, the dependability of buoyage may be reduced by the effects of strong tidal currents. Loran-C coverage is marginal, with users reporting positional errors exceeding one mile. Some loss of lock has been reported near rugged portions of the entrance shoreline. Users appear to have a perception that Loran-C is unreliable and of low value.

2.3 EXISTING TRAFFIC MANAGEMENT

The state of Alaska has established a Voluntary Traffic Separation Scheme within Kachemak Bay, the purpose of which is to assist the mariner to avoid numerous crab pots and other fixed fishing gear. The Scheme is not sanctioned by the International Maritime Organization (IMO), nor is it addressed by Federal Regulations.

The Scheme consists of two converging traffic corridors, one from the northwest and one from the southwest, each with inbound and outbound traffic lanes, and an irregularly shaped turning and anchorage area at the eastern end. The TSS is not depicted on either NOAA Chart 16640 or NOAA Chart 16645, and is not marked by aids to navigation.

2.4 VESSEL TRAFFIC

Data obtained from the U. S. Coast Guard Marine Safety Office at Anchorage provided the following annual vessel traffic data:

- o - 100 ships call at facilities in Anchorage.
- o - 25 ships call at the Drift River oil facilities. *
- o - 25 LPG ships call at Kenai. **
- o - 25 ships carrying anhydrous ammonia call at Kenai. **
- o - 25 ships carrying urea call at Kenai. **

This data corresponds to the estimation of between 350-450 transits per year provided by the Southwest Alaska Pilots Association. This data includes barge traffic, the character of which is not known. The assumption made is that there is movement of break-bulk cargo, petroleum and loaded rail cars by towed barges.

It should be noted that about half of the Anchorage movements are by TOTE (Totem Ocean Trailer Express) ships in ro-ro liner service between Anchorage and Tacoma. Since these are the same ships calling on about a seven day cycle, ships' officers are generally well acquainted with Cook Inlet.

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* Ships calling at Drift River carry crude oil to the refinery there and lift out petroleum products, primarily jet fuel, diesel oil and "saleable asphalt"

** The Kenai facilities are actually located at Nikiski, about 10 miles north of the town of Kenai.

In addition to deep-water traffic there is local activity in support of the offshore platforms located within Cook Inlet and there is, in season, a high number of fishing craft. Estimates of the numbers actually fishing at any one time range upwards to 1000. Most fishing boats are reportedly under 40' length overall (LOA) and employ either drift nets or seines. Three areas where there fishing boats tend to concentrate are off Nikiski, Drift River and Anchorage.

Although there are a modest number of recreational boats moored in and around portions of the eastern shore of Cook Inlet, their activities tend to be associated with recreational fishing rather than with cruising and racing.

Scheduled ferry service operates between Homer, Seldovia and Kodiak and there is summer ferry service between Homer and Jakolof Bay.

The upper reaches of Cook Inlet are more or less obstructed by ice during the winter months but, with care, shipping can normally use the facilities within the Inlet year 'round.' The presence of ice makes buoys unreliable and may cause them to be withdrawn. South of Anchor Point, ice seldom obstructs passage but can affect buoys and may make anchoring difficult.

Although there are no designated anchorages, ships can come to anchor at points throughout Cook Inlet. Sites for anchoring are selected based upon weather conditions and ship's characteristics.

2.5 ENVIRONMENTAL SENSITIVITY

Cook Inlet is essentially a pristine area with shoreline characteristics ranging from wooded and rocky at the entrance to subarctic wetlands in its upper reaches. Cook Inlet supports a number of commercially important fisheries, chief of which in economic terms is salmon. Herring, crab and crustaceans are also of importance. In addition to commercial and recreational fishing, the area is the habitat of other aquatic life of considerable value.

The experience of the EXXON VALDEZ oil spill has heightened sensitivity to pollution, with heavy emphasis now placed upon prevention rather than clean-up. "Worst Case" appears to be a major spill at or in the vicinity of Kenai, with wind and currents dispersing the pollutant before containment can be achieved.

2.6 PORT SUB-ZONES

The Study Area was examined to determine appropriate sub-zones, using the methodology based upon the "confined-complex", "open-complex", "confined-simple" and "open-simple" system employed by the Canadian VTS Study in 1984. Briefly stated, "open" and "confined" address the influence of geography upon a ship's ability to maneuver; and "simple" vs "complex" is descriptive of the nature of the interactions between ships within those geographic areas. This basic matrix was overlaid by a subjective assessment of appropriate traffic management/risk amelioration measures in order to derive sub-zones within which VTS needs are homogeneous, or nearly so.

2.6.1 Sub-Zone I -- Lower Cook Inlet (NOAA Chart 16640)

This sub-zone is composed of the waters of Cook Inlet south of an east-west line drawn across Cook Inlet through Anchor Point Light, excluding Kachemak Bay.

The portion of Cook Inlet within this sub-zone is an unencumbered open expanse of water where ships of all sizes are relatively free to operate at will. Along the recommended route to Anchorage and Kenai the least depth encountered is 15 fathoms. The western shore together with its fishing activities may be excluded from consideration since it lies well outside shipping lanes.

The headlands along the eastern shore are well-marked by fixed aids to navigation and during periods of low visibility the boldness of the coastline facilitates radar navigation. Loran-C coverage is marginal, with reported difficult in obtaining accurate fixes.

Consideration should be given to improving the Loran-C coverage, perhaps by increasing power or by reconfiguration of the chain. This should be followed by efforts to build mariners' confidence in that system as it is applied to Cook Inlet.

The sub-zone is classified as "open-simple."

2.6.2 Sub-Zone II -- Kachemak Bay (NOAA Chart 16645)

Sub-Zone II consists of that of Kachemak Bay lying east of a line connecting Flat Island Light and Anchor Point Light.

Shipping picking up and discharging pilots at Homer must deviate from the direct route by about 20 miles, and the Coast Pilot implies that ships have grounded at Homer while maneuvering to close the Pilot Boarding Area. Navigational problems aside, overall traffic is light in the vicinity of Homer so that risk of collision between large vessels may be considered minimal.

Making the Pilot Boarding Area does, however, require shipping to stand well into Kachemak Bay, where there is a heavy concentration of fishing activities. The State of Alaska has established a Voluntary Traffic Separation Scheme (See Section 2.3.1) to minimize conflicts and reduce the incidence of ships fouling fixed fishing gear.

The effectiveness of the Kachemak Bay Voluntary Traffic Separation Scheme would be enhanced if its lanes were overprinted on the appropriate charts, suitable marked by aids to navigation and by enforcing the TSS lanes as fairways from which fixed fishing gear was excluded.

The sub-zone is classified as "confined-simple."

2.6.3 Sub-Zone III -- Middle Cook Inlet (NOAA Charts 16661 & 16662)

This sub-zone consists of that portion of Cook Inlet lying between an east-west line drawn across Cook Inlet through Anchor Point Light, and west of 151^0-10' W.

North of Anchor Point the wide navigable expanse of Cook Inlet is narrowed to about nine miles by extensive shoals south of Kalgin Island, and is further reduced to about five miles west of Kenai. Ships can, however, find depths exceeding 20 fathoms by selection of their routes through the sub-zone. There are several buoys marking critical hazards, but these may be withdrawn during the winter or moved off station by ice. A small number of offshore oil platforms are located in the northern portion of the sub-zone and the bottom in that area is crossed by submerged pipelines.

Ships making Drift River facilities pass west of the Kalgin Island shoals and reach Redoubt Bay through its two mile wide southern entrance. The area around Drift River is one of the three most heavily fished areas within Cook Inlet. Ships calling at the Nikiski facilities, which are nearly ten miles north of the town of Kenai, must cross or skirt the shoal area lying offshore. The Nikiski area is heavily fished by gillnetters during salmon season and the currents east of the shoals are very strong.

The coastline of this sub-zone is generally low and marshy, and does not offer the definite radar returns available further south. Visual aids are available on the shore during good visibility, but insufficient provision has been made for reliable low-visibility piloting. Improvement of Loran-C coverage, building user confidence in that system, and the enhancement of radar returns, perhaps through application of frequency-agile RACONS, will assist in the fulfillment of traffic management requirements. A VTS should also be able to provide navigational assistance and traffic ma· ·ement advice.

The sub-zone is classified as "confined-simple."

2.6.4 Sub-Zone IV -- Upper Cook Inlet (NOAA Charts 16663 & 16665)

This sub-zone consists of that portion of Cook Inlet lying east and north of 151^0-10'W to the head of deep-draft navigation north of Anchorage.

Navigation becomes more complex in Sub-zone IV since Cook Inlet narrows, and because of the presence of numerous shoals. The sub-zone contains some offshore oil platforms, together with associated activities and seabed pipelines. The 15 mile segment between the southern end of Fire Island Shoal and Anchorage can be particularly challenging during foul weather and low visibility. The final approaches to Anchorage are well marked by visual aids, including ranges, but buoyage is unreliable or removed during ice season. Portions of the shoreline are sufficiently relieved to permit strong radar returns but north of Point Possession are much less distinct.

In season, there is intense fishing activity in the narrows of Kink Arm, just north of Anchorage itself, with shipping needing great care to make the piers without damaging fishing gear or standing into danger. Comments made by fishermen appear to indicate an unwillingness to reach a workable accommodation with shipping interests to minimize impediments to navigation (Reference 2).

Improvement in Loran-C coverage, building user confidence in that system, and the enhancement of radar returns, perhaps through application of frequency-agile RACONS, will help fulfill traffic management requirements. A VTS should also be able to provide navigational assistance and traffic management advice.

The sub-zone is classified as "confined-simple."

2.7 PROBLEM AREA IDENTIFIERS

2.7.1 PAI II-1. Kachemak Bay

Kachemak Bay must be entered by shipping to pick up and discharge pilots in the vicinity of Homer. The necessity to do so brings shipping into conflict with fishing activities in the Bay and has led to the establishment by the State of Alaska of a Voluntary TSS. Placement of TSS information on the appropriate charts and improved aids to navigation, including improvement the Loran-C coverage is recommended.

2.7.2 PAI III-1. Drift River

The deep-draft traffic serving the Drift River facilities consists primarily of tankers. Their approach to the facilities lies through areas of shoals and strong tidal currents, requiring accuracy of navigation and timeliness of fixes. In season, the vicinity of Drift River is heavily fished, with the potential for conflict between ships and that activity. VTS capabilities should include the provision of navigational assistance as well as traffic management advice, particularly regarding locations of fishing vessel concentrations.

2.7.3 PAI III-2. Kenai (Nikiski)

The approach to the Nikiski facilities, about 10 miles north of the town of Kenai, lies through areas of shoals and strong tidal currents, requiring accuracy of navigation and timeliness of fixes. In season, the vicinity of the Nikiski facilities are heavily fished, with the potential for conflict between tankers and that activity. VTS capabilities should include the provision of navigational assistance as well as traffic management advice, particularly regarding locations of fishing vessel concentrations.

2.7.4 PAI III-3. Kalgin Island and Associated Shoals

The long shoal area south of Kalgin Island and the Island itself requires careful navigation and timely fixes. This is particularly true, since deep-draft traffic moving south of Kalgin Island consists primarily of tankers.

2.7.5 PAI IV-1. Fire Island

The Fire Island-Fire Island Shoal portion of Upper Cook Inlet requires careful navigation and timely fixes.

2.7.6 PAI IV-2. Anchorage

The approach to the Anchorage facilities lies through areas of shoals and strong tidal currents, requiring accuracy of navigation and timeliness of fixes. In season, the vicinity of Anchorage is heavily fished, with the potential for conflict between ships and that activity. During those periods traffic management advice may be necessary, in addition to navigational assistance.

3.0 COOK INLET VTS DESIGN

3.1 INTRODUCTION

A detailed survey of the Cook Inlet is the basis for this design. An approach to costing VTS systems is outlined in Vol. III, Technical Supplement and a method of categorizing surveillance sensors into "modules" has also been developed. These modules are defined in terms of cost and performance and are to be applied to all VTS designs in this study. The applicability of Automatic Dependent Surveillance (ADS) technology is also discussed in this report. The four sub-zones defined in the harbor survey remain the same.

Traffic management requirements for each sub-zone are developed from PAI analysis. Table 3-1 lists in tabular form a summation of the problems identified and the management required by sub-zone.

The hardware and software selected for this design provide the level of surveillance justified by the problems identified in each sub-zone. A secondary consideration is to locate all VTS assets so that they are sufficient for the sub-zone in question and can contribute to adjoining sub-zones to achieve maximum usage. All specific equipments are then selected based on perceived surveillance requirements and overall VTS system architecture.

3.1.1 VTS Design Approach

The choice of surveillance sensors is dependent on the VTS mission. For the purposes of this design, the VTS mission is defined as that which insures the safety of navigation and the protection of the environment. In order to accomplish this mission, mandatory participation of all vessels over 20 meters is essential. The Vessel Traffic Center (VTC) must provide navigation safety advice to all vessels. The VTS in the United States will have no facilitation of commerce role nor will it offer piloting assistance of any kind.

The primary criteria for selection of adequate surveillance sensors are:

- o Percentage of vessels of the desired minimum size detected in designated surveillance areas
- o Percentage of lost tracks
- o Accuracy of the position and track obtained
- o Reliability of the surveillance system

TABLE 3-1. ANCHORAGE/COOK INLET, AK PROBLEM AREA IDENTIFIERS

PAI	LOCATION	PROBLEM	MANAGEMENT
I	Lower Cook Inlet	Potential vessel interactions	Have knowledge of participant movement, particularly inbound shipping. Enter inbound ships into shipping database.
II	Kachemak Bay	Potential congestion, and dissimilar traffic.	Have knowledge of ship movements to and from pilot station.
III	Middle Cook Inlet	Navigational assistance may be required. Potential conflicts between deep-draft traffic and fishermen.	Have real-time knowledge of deep-draft movements within selected areas. Be able to provide navigational assistance. Have real-time knowledge of fishing activities in selected areas, be able to provide traffic management advice.
IV	Upper Cook Inlet	Same As Above.	Same As Above.

- o Timeliness of the data obtained

- o Ability to interpret and use the data obtained

Secondary criteria are:

- o Cost of the VTS system -- reduction of manpower by the use of technology

- o Expandability -- increased VTS responsibility, area, and/or support of other missions

Active surveillance sensors including radar, communications, and closed circuit television (CCTV) installations are used when detection and tracking of vessels is paramount to providing safety advice. These devices are considered fail safe in that it is known with certainty when they have failed. The performance characteristics of these sensors are known from operational VTS worldwide experience. In this design they are selected to assure that the necessary operational criteria identified for each sub-zone is realized.

Many dependent surveillance techniques are possible. These range from voice radio reporting of required VTS data to automatic position and identification recording devices that can be interrogated from shore known as Automatic Dependent Surveillance (ADS) devices. The position and/or movement reporting form of dependent surveillance is used extensively in existing VTS systems. The major regions of current use are those which do not require active surveillance. To apply ADS technology to a specific sub-zone within a VTS zone the following additional criteria must be considered:

- o The number and class of vessels interacting in the sub-zone and which of these interactions are important to the VTS mission. Obviously all vessel classes of interest must be appropriately equipped. This requires that all vessels of the classes selected which will ever pass through this sub-zone must be equipped with an ADS device. This requirement to detect so many different vessels argues against the use of ADS. In areas where only one class of vessel is of interest, ADS is more easily implemented.

- o The interactions or transits to be monitored must not demand that the surveillance be fail safe, i.e. positively detecting failures. This type of surveillance is related to position reporting in that it may not always function or be used properly and the VTS has limited control over its operation.

o It must be determined that if active surveillance is not justified, the additional information obtained from ADS over position reporting is necessary.

o If the class or group of vessels to be monitored is a "controllable" group, ADS can be easily implemented and satisfactory operation more readily achieved. Controllable means a clearly defined subset of vessels, e.g. a specific barge company; vessels carrying a specific cargo, etc.

o The number of different vessels in each class of interest that passes through the sub-zone in question must be determined. This number must be known to accurately estimate the cost of selecting this option for this sub-zone.

o A specific ADS solution for one sub-zone in one harbor may affect all the VTS designs for all the other sub-zones in all the other harbors.

3.1.2 Assumptions

The design of this VTS system starts with a set of assumptions based on the detailed survey and other data. These assumptions are as follows:

o As recommended by the IMO, all vessels of 20 meters or more in length are required to participate in the VTS. Participation is defined (at a minimum) as monitoring the VTS frequency and reporting as required.

o The VTS system is implemented with the cooperation and assistance of the port authorities, pilots associations, and marine exchange, if any. The existing facilities, services, and procedures established and operated by these organizations are major elements of an integrated VTS system as defined in the IMO VTS Guidelines.

o The life-cycle of all system hardware is ten years.

3.2 DESIGN DECISIONS (FIGURE 3-1)

3.2.1 General

Examination of the traffic levels, geographical features and identified problem areas at Cook Inlet leads to the following selection and location of sensor hardware.

Surveillance Modules -Sub Zones	RADAR						ADS			VHF		MET.		HYD.		DF	CCTV		COMMENTS
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
I																			Comms coverage from Sub-Zone II
II											1								
III			1							1	1		1						
IV			1							1	1	1							

FIGURE 3-1. ANCHORAGE/COOK INLET, AK SURVEILLANCE SURVEY

3.2.2 Hardware Location and Selection

3.2.2.1 Sub-Zone II

Anchor Point Site	1 Module 11 VHF

3.2.2.2 Sub-Zone III

Dillon Site	1 Module 3 radar
	1 Module 10 VHF
	1 Module 11 VHF
	1 Module 13 MET

3.2.2.3 Sub-Zone IV

Point MacKenzie Site	1 Module 3 radar
	1 Module 10 VHF
	1 Module 11 VHF
	1 Module 12 MET

3.2.3 Vessel Traffic Center

The design of the hardware and software should be modern and capable of operating with reduced staff levels and no loss of effectiveness. One watchstander with an integrated data workstation and decision aiding software can effectively manage the activity in this port. This Vessel Traffic Center concept demands that the watchstander be separated from any other harbor/port information requests. The Center must be structured so that such requests are controlled by a bulletin board type interface. One officer-in-charge and one clerk are also required for the proper administration of the facility.

The Vessel Traffic Center is located in Anchorage in a location with good visual surveillance of the port. The center is to employ the following equipment:

3.2.3.1 VTS Console

This console provides total data integration from all sensors in all sectors. These data are graphically shown on raster scan, high light level, color displays. A data display is also provided. Console design architecture is general purpose computer based, open architecture, bus organized, allowing operation of the system as a local area network (LAN). Data interchange with other facilities by modem is provided as well as interface with the U.S. Coast Guard standard terminal. The design allows board level modification and expansion. Features of the software and hardware provided are:

- Software written in a high level language.
- Software providing the total integration of data from all VTS sensors.
- Layering of data in at least four layers to be operator selectable.
- The ability to sector data including sector to sector handoff of targets.
- The ability to accept external digital data derived from transmissions of shipboard transponders or other sources and integrate the information with all other sensor data.
- Automatic and/or manual acquisition of radar targets including automatic tracking and target ID assignments. Guard zones with automatic acquisition of all targets entering the zone.
- Several warning levels of vessel interaction designed to direct attention to developing situations rather than a simple CPA alarm strategy.
- Complete vessel monitoring and alarm capability including anchor watch, CPA, TCPA, track history, adjustable target velocity vectors, restricted area penetration and maneuvering monitor is provided. Additional warning and/or alarm features allowed by programming changes in high level language.
- Complete modern color graphics capability with offset and zoom
- Complete harbor navigation aid monitoring capability including buoy position, light status, etc.
- Remote control of all radars and radar interfaces as well as radar data processing including site-to-site integration, clutter suppression, scan conversion and target extraction.
- Complete track projection capability which can predict and/or analyze future interactions based on current position, destination and velocity.
- The capability of constructing a complete vessel data base and interfacing it to the real-time data display from the VTS sensors.

3.2.3.2 Communications Console

This console is capable of remotely operating the proposed transmitting/receiving sites and allowing transmission and monitoring on all required frequencies. The console provides two operating positions each to be capable of complete communications control. It is capable of modular expansion if other remote communications sites are added.

3.2.3.3 Supervisor Control and Data Acquisition (SCADA) Equipment

A SCADA capability is provided to the major module level at remote sites so that the watchstander can determine the status of the entire VTS system. A graphic readout is provided in block diagram form indicating operational status of all elements in the system. Security monitoring of remote sites is also included.

3.2.3.4 Recording Equipment

Time synchronized video and audio recording equipment is to be provided. This equipment is capable of recording and playing back the data presented to the VTS watchstander and his reaction to the situation. An extra set of recording equipment is to be installed for redundancy purposes.

3.3 COST ESTIMATES

3.3.1 General

Vol. III, Technical Supplement discusses a generalized approach to estimating VTS system costs. This approach is based on interviews with system designers and purchasers of recently constructed systems. The cost of this VTS system has been estimated using this approach and is detailed below. The assumptions made in estimating these costs are listed in Paragraph 3.1.2.

3.3.2 Hardware (x $1000)

<u>Vessel Traffic Center</u>	non-recurring	recurring(10-yr)
VTS Console (1 workstation one supervisory console & all software)	750	
Comms console	100	
Recording Equipment	100	
SCADA Equipment (2 radar sites)	300	
Sub-total:	1250	700

Sub-Zone I--Lower Cook Inlet (NOAA Chart 16640)

Comms coverage from Sub-Zone II.

Sub-Zone II--Kachemak Bay (NOAA Chart 16645))

1 Module 11 VHF	48	20
Sub-total:	48	20

Sub-Zone III--Middle Cook Inlet (NOAA Charts 16661 & 16662)

1 Module 3 radar	400	400
1 Module 10 VHF	19	13
1 Module 11 VHF	48	20
1 Module 13 MET	40	5
Sub-total:	507	438

Sub-Zone IV--Upper Cook Inlet (NOAA Charts 16663 & 16665)

1 Module 3 radar	400	400
1 Module 10 VHF	19	19
1 Module 11 VHF	48	20
1 Module 12 MET	20	5
Sub-total:	487	444
HARDWARE TOTALS:	2292	1602

3.3.3 Project Totals (x $1000)

Non-recurring

Hardware	$2292
Management, Engineering, etc. (50%) Assumptions: Turnkey system, Procurement by integ.contractor, good manufacturer support, some software provided, System Manual required	1146
Installation site integration (25%) Assumptions: Complete installation by contractor, remote access no serious problem, many widespread sites	573
Spares & Training (10%)	229
Civil Engineering 2 remote radar sites, remote comms and WX sensors installations, land acquisition, VTC in Anchorage	3000
PROJECT ESTIMATE:	7240
Data Base Management System	300
TOTAL: (non-recurring)	$ 7540

Recurring (10 year)

Hardware	1602
1 Watchstander x 5 = 5 man/years @ 50K x 10	2500
1 Officer-in-Charge	500
1 Clerk	500
TOTAL: (recurring) (10-year life)	$ 5102
TOTAL 10-YEAR PROJECT COST:	$12342

REFERENCES

1. Anchorage Climatological Table, United States Coast Pilot: Pacific and Arctic Coasts Alaska, Cape Spencer to Beaufort Sea, 14th Edition. NOAA, Washington, D.C., 1989, p. T-4.

2. Final Report, National Vessel Traffic Services Study (TP5965E), Canadian Coast Guard, Ottawa 1984, pp. 89-91.

GLOSSARY

ADS: Automatic Dependent Surveillance

ARPA: Automatic Radar Plotting Aid.

"CONFINED-COMPLEX": a combination of terms relating to the geography and the nature of the interactions between ships. See Final Report National Vessel Traffic Services Study (TP-5965E), Canadian Coast Guard, Ottawa, October 1984, pp.89-91.

"CONFINED-SIMPLE": a combination terms relating to the geography and the nature of the interactions between ships. See Final Report National Vessel Traffic Services Study (TP-5965E), Canadian Coast Guard, Ottawa, October 1984, pp.89-91.

COTP: Captain of the Port

CCTV: closed circuit television

COLREGS LINE: a demarcation line delineating those waters upon which international regulations for the prevention of collisions at sea apply.

CPA: closest point of approach

DBMS: data base management system

DF: direction finder

FAA: Federal Aviation Administration

GIS: Geographic Information System

ICW: Intracoastal Waterway

IMO: International Maritime Organization

KW: Kilowatt

LAN: local area network

LLOYD'S LIST: a listing of all merchant vessels of the world including their physical characteristics. Published by Lloyd's of London.

LNG: liquified natural gas

NOAA: National Oceanic and Atmospheric Administration

"OPEN-COMPLEX": a combination of terms relating to the geography and the nature of the interactions between ships. See Final Report National Vessel Traffic Services Study (TP-5965E), Canadian Coast Guard, Ottawa, October 1984, pp. 89-91.

"OPEN-SIMPLE": a combination of terms relating to the geography and the nature of the interactions between ships. See Final Report National Vessel Traffic Services Study (TP-5965E), Canadian Coast Guard, Ottawa, October 1984, pp. 89-91.

PAI: Problem Area Identifier

PRECAUTIONARY AREA: an area normally an intersection, entrance to, or exit from a traffic separation scheme where vessel interactions are unpredictable

SCADA: Supervisor Control and Data Acquisition

TCPA: time of closest point of approach

TRAFFIC SEPARATION SCHEME: routes incorporating traffic separation to increase the safety of navigation, particularly in converging areas of high traffic density.

VHF: very high frequency

VTC: vessel traffic center

VTS: vessel traffic services

STUDY ZONE INPUT DATA AND OUTPUT STATISTICS

TABLE 1 Assignment of COE Waterway Codes to Subzones 8/06/91

COE Waterway		Name
Subzone 1601A		
4820	A	ANCHORAGE, ALASKA
4842	A	SELDOVIA HARBOR, ALASKA
4844	A	HOMER, ALASKA
Subzone 1602C		
4820	A	ANCHORAGE, ALASKA
Subzone 1603D		
4820	A	ANCHORAGE, ALASKA

TABLE 2 Base Year 1987 Cargo Tons by Subzone, Commodity, and Vessel Type

Subzone 1601A

Comm. Code	Name	Dry Cargo	Tanker	Dry Cargo Barge Tow	Tanker Barge Tow	Total
1	FARM PRODUCTS	2,211	0	0	0	2,211
3	FISHERIES PRODUCTS	44,141	0	0	0	44,141
4	MINING PRODUCTS, NEC	12,738	0	0	0	12,738
5	PROC. FOODS & MFTRS, NEC	1,070,906	0	10	0	1,070,916
6	WASTE OF MANUFACTURING	508	0	451,500	0	452,008
1311	CRUDE PETROLEUM	0	133,751	0	0	133,751
2811	CRUDE PROD-COAL TAR-PET	334	0	0	0	334
2813	ALCOHOLS	0	1,920	0	0	1,920
2817	BENZENE AND TOLUENE	0	323	0	0	323
2871	NITROGEN CHEM FERTILIZER	195	0	0	0	195
2911	GASOLINE, INCL NATURAL	0	63,483	0	94	63,577
2912	JET FUEL	0	155,969	0	33,800	189,769
2914	DISTILLATE FUEL OIL	0	59,800	0	0	59,800
2915	RESIDUAL FUEL OIL	0	66,792	0	0	66,792
2916	LUBRIC OILS-GREASES	0	9,009	0	0	9,009
2921	LIQUI PETR-COAL-NATR GAS	0	32,753	0	0	32,753
	Subzone Total :	1,131,033	523,800	451,510	33,894	2,140,237

Subzone 1602C

Comm. Code	Name	Dry Cargo	Tanker	Dry Cargo Barge Tow	Tanker Barge Tow	Total
1	FARM PRODUCTS	2,211	0	0	0	2,211
3	FISHERIES PRODUCTS	33,255	0	0	0	33,255
4	MINING PRODUCTS, NEC	12,738	0	0	0	12,738
5	PROC. FOODS & MFTRS, NEC	1,070,035	0	5	0	1,070,040
6	WASTE OF MANUFACTURING	508	0	451,500	0	452,008
1311	CRUDE PETROLEUM	0	133,751	0	0	133,751
2811	CRUDE PROD-COAL TAR-PET	334	0	0	0	334
2813	ALCOHOLS	0	1,920	0	0	1,920
2817	BENZENE AND TOLUENE	0	323	0	0	323
2871	NITROGEN CHEM FERTILIZER	195	0	0	0	195
2911	GASOLINE, INCL NATURAL	0	61,464	0	0	61,464
2912	JET FUEL	0	155,969	0	16,900	172,869
2914	DISTILLATE FUEL OIL	0	48,327	0	0	48,327
2915	RESIDUAL FUEL OIL	0	63,054	0	0	63,054
2916	LUBRIC OILS-GREASES	0	9,009	0	0	9,009
2921	LIQUI PETR-COAL-NATR GAS	0	32,753	0	0	32,753
	Subzone Total :	1,119,276	506,570	451,505	16,900	2,094,251

TABLE 2 Base Year 1987 Cargo Tons by Subzone, Commodity, and Vessel Type

Subzone 1603D

Comm. Code	Name	Dry Cargo	Tanker	Dry Cargo Barge Tow	Tanker Barge Tow	Total
1	FARM PRODUCTS	2,211	0	0	0	2,211
3	FISHERIES PRODUCTS	33,255	0	0	0	33,255
4	MINING PRODUCTS, NEC	12,738	0	0	0	12,738
5	PROC. FOODS & MFTRS, NEC	1,070,035	0	5	0	1,070,040
6	WASTE OF MANUFACTURING	508	0	451,500	0	452,008
1311	CRUDE PETROLEUM	0	133,751	0	0	133,751
2811	CRUDE PROD-COAL TAR-PET	334	0	0	0	334
2813	ALCOHOLS	0	1,920	0	0	1,920
2817	BENZENE AND TOLUENE	0	323	0	0	323
2871	NITROGEN CHEM FERTILIZER	195	0	0	0	195
2911	GASOLINE, INCL NATURAL	0	61,464	0	0	61,464
2912	JET FUEL	0	155,969	0	16,900	172,869
2914	DISTILLATE FUEL OIL	0	48,327	0	0	48,327
2915	RESIDUAL FUEL OIL	0	63,054	0	0	63,054
2916	LUBRIC OILS-GREASES	0	9,009	0	0	9,009
2921	LIQUI PETR-COAL-NATR GAS	0	32,753	0	0	32,753
	Subzone Total :	1,119,276	506,570	451,505	16,900	2,094,251

Appendix P ZONE 16 Anchorage/Cook Inlet, AK

TABLE 3 Base Year (1987)
Vessel Transits by Subzone, Vessel Type, and Size.

Vessel Type	Large	Medium	Small	Total
Subzone : 1601A				
Passenger	0	0	220	220
Dry Cargo	49	326	75	450
Tanker	25	50	25	100
Dry Cargo Barge Tow	27	0	53	80
Tanker Barge Tow	2	0	54	56
Tug/Tow Boat	0	0	135	135
Subzone Total:	103	376	561	1,040
Subzone : 1602C				
Dry Cargo	49	326	34	409
Tanker	25	50	1	76
Dry Cargo Barge Tow	27	0	45	72
Tanker Barge Tow	2	0	10	12
Tug/Tow Boat	0	0	52	52
Subzone Total:	103	376	141	620
Subzone : 1603D				
Dry Cargo	49	326	34	409
Tanker	25	50	1	76
Dry Cargo Barge Tow	27	0	45	72
Tanker Barge Tow	2	0	10	12
Tug/Tow Boat	0	0	52	52
Subzone Total:	103	376	141	620

Note: Sum of all vessel transits within each study subzone.

Appendix P ZONE 16 Anchorage/Cook Inlet, AK

TABLE 3 Base Year (1987)
Vessel Transits by Suzone, Vessel Type, Size.

ZONE TOTALS

ZONE 16 Anchorage/Cook Inlet, AK

Vessel Type	Large	Medium	Small	Total
Passenger	0	0	220	220
Dry Cargo	49	326	75	450
Tanker	25	50	25	100
Dry Cargo Barge Tow	27	0	53	80
Tanker Barge Tow	2	0	54	56
Tug/Tow Boat	0	0	135	135
Zone Total:	103	376	561	1,040

Note: Sum of all arrivals/departures to/from all terminals within the Study Zone.

Appendix P ZONE 16 Anchorage/Cook Inlet, AK

TABLE 4 Barges Per Tow - Average Factors by COE Waterway 8/6/91

COE Code	Waterway Name	Dry Barge	Tank Barge
	SUBZONE 1601A		
4820	ANCHORAGE, ALASKA	4	4
	SUBZONE 1602C		
4820	ANCHORAGE, ALASKA	4	4
	SUBZONE 1603D		
4820	ANCHORAGE, ALASKA	4	4

NOTE: Average size of tows arriving/departing terminals within the waterway. Sizes of other tows transiting the area may differ.

Appendix P Zone 16 Anchorage/Cook Inlet, AK

TABLE 5 Other Local Vessels by Subzone 7/21/91

Subzone	Name	Number of Vessels	Vessels per Square Mile
1601A	-	1,250	.27
1602C		1,876	.58
1603D		626	52.17
	Total for Zone	3,752	.47

Note: State registered (1989/90) vessels estimated to be operated within the Subzone.

TABLE 6.1 Forecast 1995
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 1601A				
Passenger	0	0	237	237
Dry Cargo	56	353	80	489
Tanker	27	55	25	107
Dry Cargo Tow	0	0	53	53
Tanker Tow	0	0	57	57
Tug/Tow Boat	0	0	88	88
Subzone Total:	83	408	539	1,030
Subzone : 1602C				
Dry Cargo	56	353	39	448
Tanker	27	55	1	83
Dry Cargo Tow	0	0	45	45
Tanker Tow	0	0	11	11
Tug/Tow Boat	0	0	49	49
Subzone Total:	83	408	144	635
Subzone : 1603D				
Dry Cargo	56	353	39	448
Tanker	27	55	1	83
Dry Cargo Tow	0	0	45	45
Tanker Tow	0	0	11	11
Tug/Tow Boat	0	0	49	49
Subzone Total:	83	408	144	635

Note: Sum of all vessel transits within each study subzone.

Appendix P ZONE 16 Anchorage/Cook Inlet, AK

TABLE 6.2 Forecast 2000
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 1601A				
Passenger	0	0	256	256
Dry Cargo	61	374	84	519
Tanker	28	59	26	113
Dry Cargo Tow	0	0	60	60
Tanker Tow	0	0	60	60
Tug/Tow Boat	0	0	91	91
Subzone Total:	89	433	577	1,099
Subzone : 1602C				
Dry Cargo	61	374	42	477
Tanker	28	59	1	88
Dry Cargo Tow	0	0	52	52
Tanker Tow	0	0	11	11
Tug/Tow Boat	0	0	51	51
Subzone Total:	89	433	157	679
Subzone : 1603D				
Dry Cargo	61	374	42	477
Tanker	28	59	1	88
Dry Cargo Tow	0	0	52	52
Tanker Tow	0	0	11	11
Tug/Tow Boat	0	0	51	51
Subzone Total:	89	433	157	679

Note: Sum of all vessel transits within each study subzone.

Appendix P ZONE 16 Anchorage/Cook Inlet, AK

TABLE 6.3 Forecast 2005
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 1601A				
Passenger	0	0	267	267
Dry Cargo	67	395	88	550
Tanker	30	64	26	120
Dry Cargo Tow	0	0	60	60
Tanker Tow	0	0	63	63
Tug/Tow Boat	0	0	94	94
Subzone Total:	97	459	597	1,153
Subzone : 1602C				
Dry Cargo	67	395	46	508
Tanker	30	64	1	95
Dry Cargo Tow	0	0	52	52
Tanker Tow	0	0	12	12
Tug/Tow Boat	0	0	53	53
Subzone Total:	97	459	163	719
Subzone : 1603D				
Dry Cargo	67	395	46	508
Tanker	30	64	1	95
Dry Cargo Tow	0	0	52	52
Tanker Tow	0	0	12	12
Tug/Tow Boat	0	0	53	53
Subzone Total:	97	459	163	719

Note: Sum of all vessel transits within each study subzone.

Appendix P ZONE 16 Anchorage/Cook Inlet, AK

TABLE 6.4 Forecast 2010
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 1601A				
Passenger	0	0	280	280
Dry Cargo	73	415	91	579
Tanker	31	69	26	126
Dry Cargo Tow	0	0	60	60
Tanker Tow	0	0	64	64
Tug/Tow Boat	0	0	95	95
Subzone Total:	104	484	616	1,204
Subzone : 1602C				
Dry Cargo	73	415	50	538
Tanker	31	69	1	101
Dry Cargo Tow	0	0	52	52
Tanker Tow	0	0	12	12
Tug/Tow Boat	0	0	53	53
Subzone Total:	104	484	168	756
Subzone : 1603D				
Dry Cargo	73	415	50	538
Tanker	31	69	1	101
Dry Cargo Tow	0	0	52	52
Tanker Tow	0	0	12	12
Tug/Tow Boat	0	0	53	53
Subzone Total:	104	484	168	756

Note: Sum of all vessel transits within each study subzone.

Appendix P ZONE 16 Anchorage/Cook Inlet, AK

TABLE 6.5 Forecast 1995 - 2010 Vessel Transits by Vessel Type and Size

Vessel Type	Large	Medium	Small	Total
1995 FORECASTED ZONE TOTALS				
Passenger	0	0	237	237
Dry Cargo	55	348	76	479
Tanker	27	55	25	107
Dry Cargo Tow	0	0	53	53
Tanker Tow	0	0	57	57
Tug/Tow Boat	0	0	88	88
1995 Zone Total:	82	403	535	1,020
2000 FORECASTED ZONE TOTALS				
Passenger	0	0	256	256
Dry Cargo	60	365	76	501
Tanker	28	59	26	113
Dry Cargo Tow	0	0	60	60
Tanker Tow	0	0	60	60
Tug/Tow Boat	0	0	91	91
2000 Zone Total:	88	424	569	1,081
2005 FORECASTED ZONE TOTALS				
Passenger	0	0	267	267
Dry Cargo	66	384	79	529
Tanker	30	64	26	120
Dry Cargo Tow	0	0	60	60
Tanker Tow	0	0	63	63
Tug/Tow Boat	0	0	94	94
2005 Zone Total:	96	448	588	1,132
2010 FORECASTED ZONE TOTALS				
Passenger	0	0	280	280
Dry Cargo	72	403	82	557
Tanker	31	69	26	126
Dry Cargo Tow	0	0	60	60
Tanker Tow	0	0	64	64
Tug/Tow Boat	0	0	95	95
2010 Zone Total:	103	472	607	1,182

Note: Sum of all arrivals/departures to/from all terminals within the study zone.

TABLE 7 Vessel Casualty History (10 Year Totals) by Subzone, Vessel Type and Size, and Casualty Type

Vessel Type	Size	Collisions	Rammings	Groundings	Other	Total
Subzone: 1601A						
Dry Cargo	Small	0	0	1	0	1
Subzone Totals:		0	0	1	0	1
Subzone: 1602C						
Dry Cargo	Medium	1	0	1	0	2
Tanker	Large	0	0	1	0	1
Fishing	Small	1	0	0	0	1
Subzone Totals:		2	0	2	0	4
Subzone: 1603D						
Tanker	Large	0	0	1	0	1
Subzone Totals:		0	0	1	0	1
Zone Totals:		2	0	4	0	6

Note: OTHER equals barge breakaways and weather caused vessel casualties.

APPENDIX TABLE P-8 ZONE 16, ANCHORAGE/COOK INLET, AK - VTS LEVELS IN OPERATION

(Not Applicable to This Sub-Zone.)

APPENDIX TABLE P-9 ZONE 16, ANCHORAGE/COOK INLET, AK
CANDIDATE VTS DESIGN - 1995-2010

UNITS		
0	Radar Module 1	- Average Performance
0	Radar Module 2	- Average Performance
2	Radar Module 3	- High Performance
0	Radar Module 4	- High Performance
0	Radar Module 5	- Special Purpose
0	Radar Module 6	- Special Purpose
0	ADS Module 7	- Active Radar Transponder (Type 1)
0	ADS Module 8	- Positional Transponder, Small Area, Very High Accuracy (Type 5)
0	ADS Module 9	- Positional Transponder, Small Area, High Accuracy (Type 6)
2	VHF Module 10	- Low power VHF Transmitting/ Receiving Facility
3	VHF Module 11	- High power VHF Transmitting/ Receiving Facility
1	Meteorological Module 12	- Air temperature, wind direction and speed
1	Meteorological Module 13	- Air temperature, wind direction and speed, visibility
0	Hydrological Module 14	- Water Temperature and Depth
0	Hydrological Module 15	- Water Temperature, Depth and Current
0	VHF/DF MODULE 16	- Line of position measurement to 2 degree RMS
0	CCTV MODULE 17	- Fixed Focus CCTV via Telephone Lines
0	CCTV MODULE 18	- Remotely Controllable CCTV via

TABLE 10A — Avoided Vessel Casualties 1996 - 2010 — 7/31/91

Candidate VTS Systems

Counts

Vessel Type	Size	Collision	Ramming	Grounding	Total
Passenger	Small	.00	.00	.00	.00
Dry Cargo	Large	.13	.03	.22	.37
Dry Cargo	Medium	.31	.06	.17	.53
Dry Cargo	Small	.01	.00	.00	.02
Tanker	Large	.12	.03	.22	.37
Tanker	Medium	.03	.00	.03	.06
Tanker	Small	.00	0.00	.00	.00
Dry Cargo Barge T	Small	.07	.02	.04	.13
Tanker Barge Tow	Small	.02	.00	.02	.04
Tug/Tow Boat	Small	.01	.00	.01	.02
		.69	.15	.70	1.55

Undiscounted Total Dollar Losses (1,000)

Vessel Type	Size	Collision	Ramming	Grounding	Total
Passenger	Small	0	0	0	1
Dry Cargo	Large	174	40	68	282
Dry Cargo	Medium	446	96	49	592
Dry Cargo	Small	8	1	2	11
Tanker	Large	518	136	443	1,097
Tanker	Medium	96	9	16	122
Tanker	Small	0	0	0	0
Dry Cargo Barge T	Small	4	1	1	5
Tanker Barge Tow	Small	40	9	7	56
Tug/Tow Boat	Small	1	0	1	1
		1,288	292	587	2,166

Note: In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 11 Avoided Fatalities 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Small	.00	.00	.00	.00
Dry Cargo	Large	.02	.00	.03	.05
Dry Cargo	Medium	.04	.01	.02	.07
Dry Cargo	Small	.00	.00	.00	.00
Tanker	Small	.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	.00	.00	.00	.00
Tanker Barge Tow	Small	.00	.00	.00	.00
Tug/Tow Boat	Small	.00	.00	.00	.00
Totals		.06	.01	.05	.11
Candidate VTS Design - Dollars					
Passenger	Small	18.81	13.21	42.04	74.07
Dry Cargo	Large	24,365.17	4,798.48	41,038.78	70,202.43
Dry Cargo	Medium	57,724.92	10,768.30	31,245.50	99,738.71
Dry Cargo	Small	1,146.63	151.82	277.83	1,576.27
Tanker	Small	.84	0.00	1.01	1.85
Dry Cargo Barge Tow	Small	234.37	81.46	129.80	445.63
Tanker Barge Tow	Small	59.14	12.95	56.07	128.16
Tug/Tow Boat	Small	26.21	10.71	28.74	65.67
Totals		83,576.10	15,836.93	72,819.77	172,232.79

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 12 Avoided Human Injuries 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Small	.00	.00	.00	.00
Dry Cargo	Large	.00	.00	.00	.01
Dry Cargo	Medium	.00	.00	.00	.01
Dry Cargo	Small	.01	.00	.00	.01
Tanker	Small	.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	.00	.00	.00	.00
Tanker Barge Tow	Small	.00	.00	.00	.00
Tug/Tow Boat	Small	.00	.00	.00	.00
Totals		.02	.00	.01	.03
Candidate VTS Design - Dollars					
Passenger	Small	35.42	24.88	79.17	139.47
Dry Cargo	Large	418.34	82.39	704.63	1,205.36
Dry Cargo	Medium	991.12	184.89	536.48	1,712.49
Dry Cargo	Small	2,159.11	285.88	523.15	2,968.14
Tanker	Small	1.48	0.00	1.76	3.23
Dry Cargo Barge Tow	Small	409.53	142.33	226.80	778.66
Tanker Barge Tow	Small	103.34	22.63	97.97	223.94
Tug/Tow Boat	Small	45.81	18.71	50.23	114.75
Totals		4,164.14	761.71	2,220.18	7,146.03

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 13 Avoided Vessels Damaged 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Small	.00	.00	.00	.00
Dry Cargo	Large	.10	.02	.02	.14
Dry Cargo	Medium	.23	.04	.02	.28
Dry Cargo	Small	.01	.00	.00	.01
Tanker	Large	.09	.03	.03	.14
Tanker	Medium	.02	.00	.00	.03
Tanker	Small	.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	.05	.01	.01	.07
Tanker Barge Tow	Small	.01	.00	.00	.02
Tug/Tow Boat	Small	.00	.00	.00	.00
Totals		.52	.10	.08	.70
Candidate VTS Design - Dollars					
Passenger	Small	56.91	31.24	70.48	158.63
Dry Cargo	Large	70,818.78	13,347.28	12,637.87	96,803.92
Dry Cargo	Medium	202,696.83	36,186.04	7,193.90	246,076.78
Dry Cargo	Small	1,942.60	209.15	389.09	2,540.84
Tanker	Large	70,051.53	19,949.33	62,580.22	152,581.09
Tanker	Medium	15,650.19	1,807.05	6,140.93	23,598.17
Tanker	Small	16.73	0.00	25.99	42.72
Dry Cargo Barge Tow	Small	3,141.20	604.52	277.76	4,023.49
Tanker Barge Tow	Small	968.36	117.43	213.16	1,298.96
Tug/Tow Boat	Small	100.02	26.25	106.65	232.92
Totals		365,443.17	72,278.30	89,636.05	527,357.52

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 14 Avoided Cargo Damage/Loss 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Small	.00	.00	.00	.00
Dry Cargo	Large	.03	.01	.02	.06
Dry Cargo	Medium	.08	.02	.02	.12
Dry Cargo	Small	.00	.00	.00	.00
Tanker	Large	.03	.01	.02	.06
Tanker	Medium	.01	.00	.00	.01
Tanker	Small	.00	0.00	.00	.00
Dry Cargo Tow	Small	.01	.00	.00	.02
Tanker Tow	Small	.00	.00	.00	.00
Tug/Tow Boat	Small	.00	.00	.00	.00
Totals		.17	.04	.06	.28
Candidate VTS Design - Dollars					
Passenger	Small	.14	.08	.16	.38
Dry Cargo	Large	364.61	101.73	58.07	524.42
Dry Cargo	Medium	863.82	228.30	44.22	1,136.34
Dry Cargo	Small	8.82	.95	1.75	11.51
Tanker	Large	2,052.07	556.91	3,149.38	5,758.36
Tanker	Medium	118.18	13.46	31.89	163.53
Tanker	Small	.21	0.00	.16	.36
Tanker Tow	Small	305.68	67.23	117.55	490.46
Tug/Tow Boat	Small	1.20	.32	1.25	2.77
Totals		3,714.74	968.98	3,404.42	8,088.14

Note1: Dollar values include bulk petroleum and chemical cargos only and all vessel fuels spilled. Dollar values exclude cargo loss/damage for non-tank vessel types.

Note2: In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 15 Avoided NavAid Damage 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Small	0.00	.00	.00	.00
Dry Cargo	Large	0.00	.00	.00	.00
Dry Cargo	Medium	0.00	.01	.00	.01
Dry Cargo	Small	0.00	.00	.00	.00
Tanker	Large	0.00	.00	.00	.00
Tanker	Medium	0.00	.00	.00	.00
Tanker	Small	0.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	0.00	.00	.00	.00
Tanker Barge Tow	Small	0.00	.00	.00	.00
Tug/Tow Boat	Small	0.00	.00	.00	.00
Totals		0.00	.02	.00	.02
Candidate VTS Design - Dollars					
Passenger	Small	0.00	.09	.01	.10
Dry Cargo	Large	0.00	16.47	7.05	23.52
Dry Cargo	Medium	0.00	36.95	5.37	42.32
Dry Cargo	Small	0.00	1.02	.09	1.11
Tanker	Large	0.00	20.48	7.16	27.64
Tanker	Medium	0.00	2.20	.84	3.05
Tanker	Small	0.00	0.00	.01	.01
Dry Cargo Barge Tow	Small	0.00	15.91	1.27	17.18
Tanker Barge Tow	Small	0.00	2.53	.55	3.08
Tug/Tow Boat	Small	0.00	2.09	.28	2.37
Totals		0.00	97.74	22.64	120.38

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 16 Avoided Bridge Damage 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Dry Cargo	Small	0.00	0.00	0.00	0.00
Totals		0.00	0.00	0.00	0.00
Candidate VTS Design - Dollars					
Dry Cargo	Small	0.00	0.00	0.00	0.00
Totals		0.00	0.00	0.00	0.00

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

Appendix P Zone 16 Anchorage/Cook Inlet, AK
TABLE 17 Avoided Hazardous Commodity Spills 1996 - 2010 7/30/91

Commodity	Catastrophic	Large	Medium	Small	Total
Candidate Vts Design - Counts					
BENZENE AND TOLUENE	0.00	.00	.00	.00	.00
ALCOHOLS	0.00	.00	.00	.00	.00
DISTILLATE FUEL OIL	.00	.00	.00	.00	.01
RESIDUAL FUEL OIL	.00	.00	.05	.11	.16
GASOLINE, INCL NATURAL	.00	.00	.00	.00	.00
CRUDE PETROLEUM	.00	.00	.00	.00	.00
JET FUEL	.00	.00	.01	.00	.01
	.00	.01	.06	.12	.19

Note: In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

Appendix P Zone 16 Anchorage/Cook Inlet, AK
TABLE 18A

Annual Benefit & Cost Streams
Candidate VTS Systems

7/31/91

Discounted to 1993

Year	Investment ($1,000)	Operation & Maintenance ($1,000)	Benefits ($1,000)
1993	11,113	0	0
1996	0	402	106
1997	0	365	97
1998	0	332	89
1999	0	302	82
2000	0	274	75
2001	0	249	69
2002	0	227	63
2003	0	206	58
2004	0	187	55
2005	0	170	49
2006	0	155	45
2007	0	141	41
2008	0	128	38
2009	0	116	35
2010	0	106	32
	11,113	3,360	935

Undiscounted

Year	Investment ($1,000)	Operation & Maintenance ($1,000)	Benefits ($1,000)
1993	11,113	0	0
1996	0	510	135
1997	0	510	136
1998	0	510	137
1999	0	510	138
2000	0	510	139
2001	0	510	141
2002	0	510	143
2003	0	510	144
2004	0	510	150
2005	0	510	146
2006	0	510	149
2007	0	510	150
2008	0	510	151
2009	0	510	152
2010	0	510	153
	11,113	7,653	2,1[illegible]6

APPENDIX P

ZONE 16 - ANCHORAGE/COOK INLET, AK

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Cook Inlet Port & Subzone	Species Category	(Port 16) Species Code	Species Name	Wildlife Abundance Tables Fish & Shellfish Grams per Square Meter Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
1601	101	62	Coho Salmon	.0001	.0112	0.0000	0.0000
1601	101	78	Sockeye Salmon	.0081	.0188	0.0000	0.0000
1601	101	79	Chum Salmon	.0011	.0543	0.0000	0.0000
1601	101	80	Pink Salmon	.0035	.0657	0.0000	0.0000
1601	101	81	Chinook Salmon	.0002	.0001	0.0000	0.0000
1601	102	86	Pacific Herring	1.4160	1.4160	0.0000	0.0000
1601	102	97	Walleyed Pollock	2.6770	2.6770	2.1730	1.7830
1601	105	87	Pacific Flatfish	.9410	.9410	3.3540	0.0000
1601	105	88	Pacific Halibut	1.6850	1.6850	2.0200	0.0000
1601	106	90	Deepwater Rockfish	.1040	.1040	.1040	.1040
1601	106	90	Demersal Rockfish	.0240	.0240	.0240	.0240
1601	106	92	Sablefish	.0040	.0040	.1250	.0040
1601	106	93	Pacific Cod	.3090	.3090	.4860	0.0000
1601	106	109	Sculpin	.1010	.1010	.1010	.1010
1601	106	199	Greenling	85.0000	85.0000	0.0000	0.0000
1601	107	103	Capelin Smelt	.0470	.0470	.0470	.0470
1601	107	299	Pacific Clam	.0782	.0782	.0782	.0782
1601	108	221	Dungeness Crab	.0895	.0895	.0895	0.0000
1601	108	222	Pacific Shrimp	.3719	.3719	0.0000	0.0000
1601	108	225	King Crab	.1334	0.0000	0.0000	.1334
1601	109	223	Pacific Squid	.0191	.0191	.0191	.0191
1602	101	62	Coho Salmon	.0001	.0112	0.0000	0.0000
1602	101	78	Sockeye Salmon	.0081	.0188	0.0000	0.0000
1602	101	79	Chum Salmon	.0011	.0543	0.0000	0.0000
1602	101	80	Pink Salmon	.0035	.0657	0.0000	0.0000
1602	101	81	Chinook Salmon	.0002	.0001	0.0000	0.0000
1602	102	86	Pacific Herring	1.4160	1.4160	0.0000	0.0000
1602	102	97	Walleyed Pollock	2.6770	2.6770	2.1730	1.7830
1602	105	87	Pacific Flatfish	.9410	.9410	3.3540	0.0000
1602	105	88	Pacific Halibut	1.6850	1.6850	2.0200	0.0000
1602	106	90	Deepwater Rockfish	.1040	.1040	.1040	.1040
1602	106	90	Demersal Rockfish	.0240	.0240	.0240	.0240
1602	106	92	Sablefish	.0040	.0040	.1250	.0040
1602	106	93	Pacific Cod	.3090	.3090	.4860	0.0000
1602	106	109	Sculpin	.1010	.1010	.1010	.1010
1602	106	199	Greenling	85.0000	85.0000	0.0000	0.0000
1602	107	103	Capelin Smelt	.0470	.0470	.0470	.0470
1602	107	299	Pacific Clam	.0782	.0782	.0782	.0782
1602	108	221	Dungeness Crab	.0895	.0895	.0895	0.0000
1602	108	222	Pacific Shrimp	.3719	.3719	0.0000	0.0000
1602	108	225	King Crab	.1334	0.0000	0.0000	.1334
1602	109	223	Pacific Squid	.0191	.0191	.0191	.0191
1603	101	62	Coho Salmon	.0001	.0112	0.0000	0.0000
1603	101	78	Sockeye Salmon	.0081	.0188	0.0000	0.0000
1603	101	79	Chum Salmon	.0011	.0543	0.0000	0.0000
1603	101	80	Pink Salmon	.0035	.0657	0.0000	0.0000
1603	101	81	Chinook Salmon	.0002	.0001	0.0000	0.0000
1603	102	86	Pacific Herring	1.4160	1.4160	0.0000	0.0000
1603	102	97	Walleyed Pollock	2.6770	2.6770	2.1730	1.7830
1603	105	87	Pacific Flatfish	.9410	.9410	3.3540	0.0000
1603	105	88	Pacific Halibut	1.6850	1.6850	2.0200	0.0000
1603	106	90	Deepwater Rockfish	.1040	.1040	.1040	.1040
1603	106	90	Demersal Rockfish	.0240	.0240	.0240	.0240

APPENDIX P

ZONE 16 - ANCHORAGE/COOK INLET, AK (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Cook Inlet		(Port 16)		Wildlife Abundance Tables Fish & Shellfish Grams per Square Meter			
Port & Subzone	Species Category	Species Code	Species Name	Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
1603	106	109	Sculpin	.1010	.1010	.1010	.1010
1603	106	199	Greenling	85.0000	85.0000	0.0000	0.0000
1603	107	103	Capelin Smelt	.0470	.0470	.0470	.0470
1603	107	299	Pacific Clam	.0782	.0782	.0782	.0782
1603	108	221	Dungeness Crab	.0895	.0895	.0895	0.0000
1603	108	222	Pacific Shrimp	.3719	.3719	0.0000	0.0000
1603	108	225	King Crab	.1334	0.0000	0.0000	.1334
1603	109	223	Pacific Squid	.0191	.0191	.0191	.0191
1603	106	92	Sablefish	.0040	.0040	.1250	.0040
1603	106	93	Pacific Cod	.3090	.3090	.4860	0.0000

APPENDIX P

ZONE 16 - ANCHORAGE/COOK INLET, AK (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Cook Inlet Port & Subzone	Species Category	(Port 16) Species Code	Species Name	Wildlife Abundance Tables Fish & Shellfish Larvae Numbers per Square Meter Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
1601	202	1086	Herring	0.0000	50.0000	0.0000	0.0000
1601	202	1110	Sand Lance	100.0000	0.0000	0.0000	75.0000
1601	205	1087	Flatfish	75.0000	6.0000	0.0000	0.0000
1601	206	1086	Capelin	10.0000	1000.0000	10.0000	1.0000
1601	206	1093	Cod, Pollock	10.0000	4.0000	0.0000	0.0000
1601	206	1103	Smelt, Eulachon	2.0000	1000.0000	8.0000	50.0000
1601	207	1199	Larvae	.0002	.0019	.0002	0.0000
1601	208	1199	Larvae	.0160	.0420	0.0000	0.0000
1602	202	1086	Herring	0.0000	50.0000	0.0000	0.0000
1602	202	1110	Sand Lance	100.0000	0.0000	0.0000	75.0000
1602	205	1087	Flatfish	75.0000	6.0000	0.0000	0.0000
1602	206	1086	Capelin	10.0000	1000.0000	10.0000	1.0000
1602	206	1093	Cod, Pollock	10.0000	4.0000	0.0000	0.0000
1602	206	1103	Smelt, Eulachon	2.0000	1000.0000	8.0000	50.0000
1602	207	1199	Larvae	.0002	.0019	.0002	0.0000
1602	208	1199	Larvae	.0160	.0420	0.0000	0.0000
1603	202	1199	Larvae	19.5000	84.6000	84.6000	22.8000
1603	205	1199	Larvae	54.5000	32.7000	17.8000	.2000
1603	206	1199	Larvae	.2700	4.6000	10.1000	.2000
1603	207	1199	Larvae	.0095	.0950	.0095	0.0000
1603	208	1199	Larvae	.1600	.4200	0.0000	0.0000

APPENDIX P

ZONE 16 - ANCHORAGE/COOK INLET, AK (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Cook Inlet		(Port 16)		Wildlife Abundance Tables Birds Numbers per Square Kilometer			
Port & Subzone	Species Category	Species Code	Species Name	Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
1601	111	302	Divers	67.0000	53.0000	30.0000	27.5000
1601	111	307	Geese	17.5000	.0010	1.0000	.0010
1601	111	511	Dabblers	1.2000	.5000	10.3000	5.0000
1601	111	517	Grebes	.0010	0.0000	.0010	.0010
1601	112	315	Phalaropes	.0800	.4000	0.0000	0.0000
1601	113	321	Gulls	26.3000	77.3000	26.5000	8.3000
1601	113	322	Cormorants	.0010	.0010	2.0000	1.0000
1601	113	323	Auclids	.5000	.5000	0.0000	4.6000
1601	113	325	Storm Petrels	.0010	.7000	.2000	0.0000
1601	113	332	Loons	.0010	.0010	.0010	.0010
1601	113	532	Kittiwakes	25.5000	6.7000	0.0000	0.0000
1601	113	533	Terns	0.0000	1.5000	0.0000	0.0000
1601	113	538	Murres	3.0000	27.2000	.0200	.0200
1601	113	539	Guillemots	.1000	.1000	.1000	.1000
1601	113	540	Puffins	1.2000	1.2000	1.1000	0.0000
1602	111	302	Divers	67.0000	53.0000	30.0000	27.5000
1602	111	307	Geese	17.5000	.0010	1.0000	.0010
1602	111	511	Dabblers	1.2000	.5000	10.3000	5.0000
1602	111	517	Grebes	.0010	0.0000	.0010	.0010
1602	112	315	Phalaropes	.0800	.4000	0.0000	0.0000
1602	113	321	Gulls	26.3000	77.3000	26.5000	8.3000
1602	113	322	Cormorants	.0010	.0010	2.0000	1.0000
1602	113	323	Auclids	.5000	.5000	0.0000	4.6000
1602	113	325	Storm Petrels	.0010	.7000	.2000	0.0000
1602	113	332	Loons	.0010	.0010	.0010	.0010
1602	113	532	Kittiwakes	25.5000	6.7000	0.0000	0.0000
1602	113	533	Terns	0.0000	1.5000	0.0000	0.0000
1602	113	538	Murres	3.0000	27.2000	.0200	.0200
1602	113	539	Guillemots	.1000	.1000	.1000	.1000
1602	113	540	Puffins	1.2000	1.2000	1.1000	0.0000
1603	111	302	Divers	67.0000	53.0000	30.0000	27.5000
1603	111	307	Geese	17.5000	.0010	1.0000	.0010
1603	111	511	Dabblers	1.2000	.5000	10.3000	5.0000
1603	111	517	Grebes	.0010	0.0000	.0010	.0010
1603	112	315	Phalaropes	.0800	.4000	0.0000	0.0000
1603	113	321	Gulls	26.3000	77.3000	26.5000	8.3000
1603	113	322	Cormorants	.0010	.0010	2.0000	1.0000
1603	113	323	Auclids	.5000	.5000	0.0000	4.6000
1603	113	325	Storm Petrels	.0010	.7000	.2000	0.0000
1603	113	332	Loons	.0010	.0010	.0010	.0010
1603	113	532	Kittiwakes	25.5000	6.7000	0.0000	0.0000
1603	113	533	Terns	0.0000	1.5000	0.0000	0.0000
1603	113	538	Murres	3.0000	27.2000	.0200	.0200
1603	113	539	Guillemots	.1000	.1000	.1000	.1000
1603	113	540	Puffins	1.2000	1.2000	1.1000	0.0000

APPENDIX Q

PORTLAND, ME

(ZONE 17)

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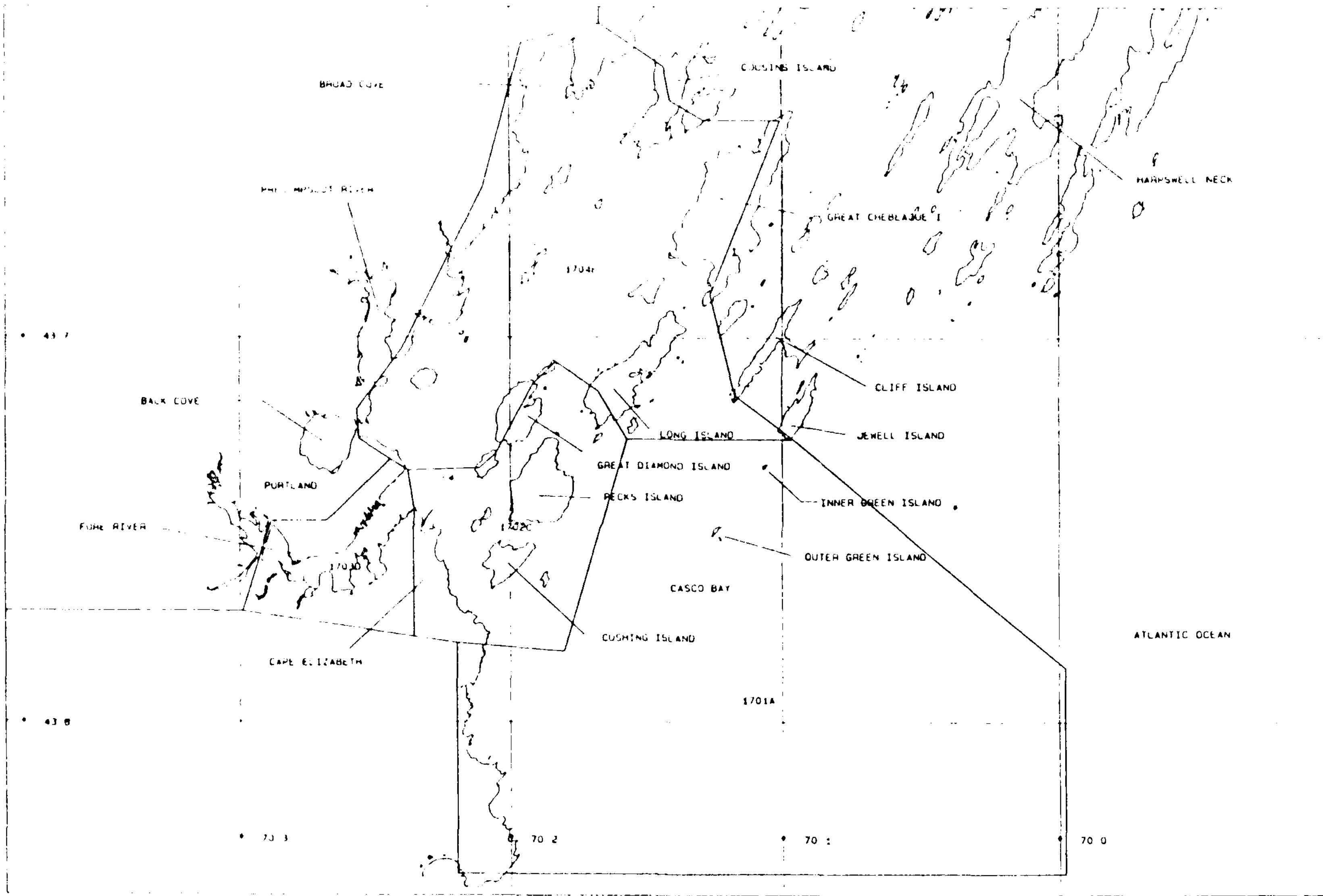
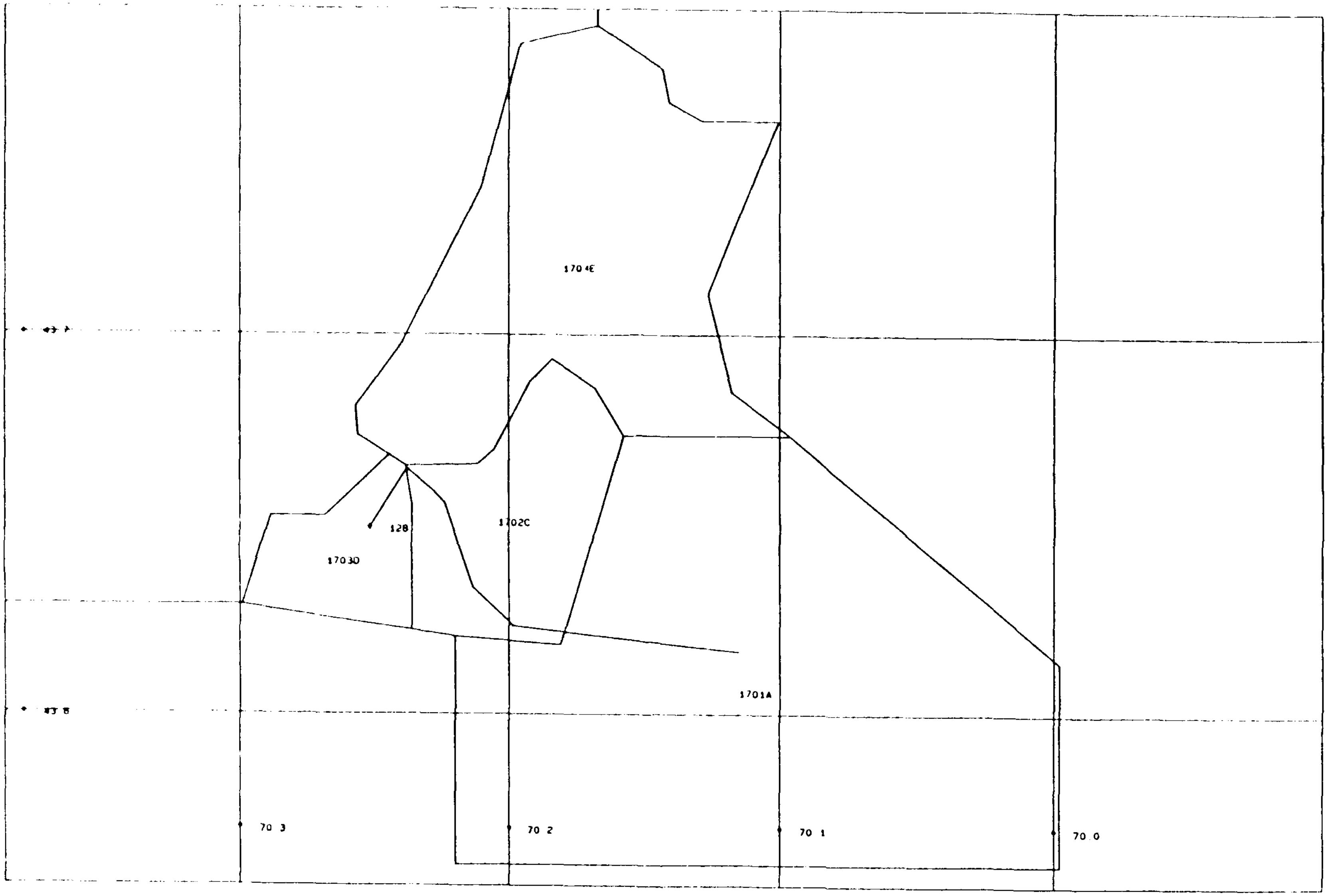
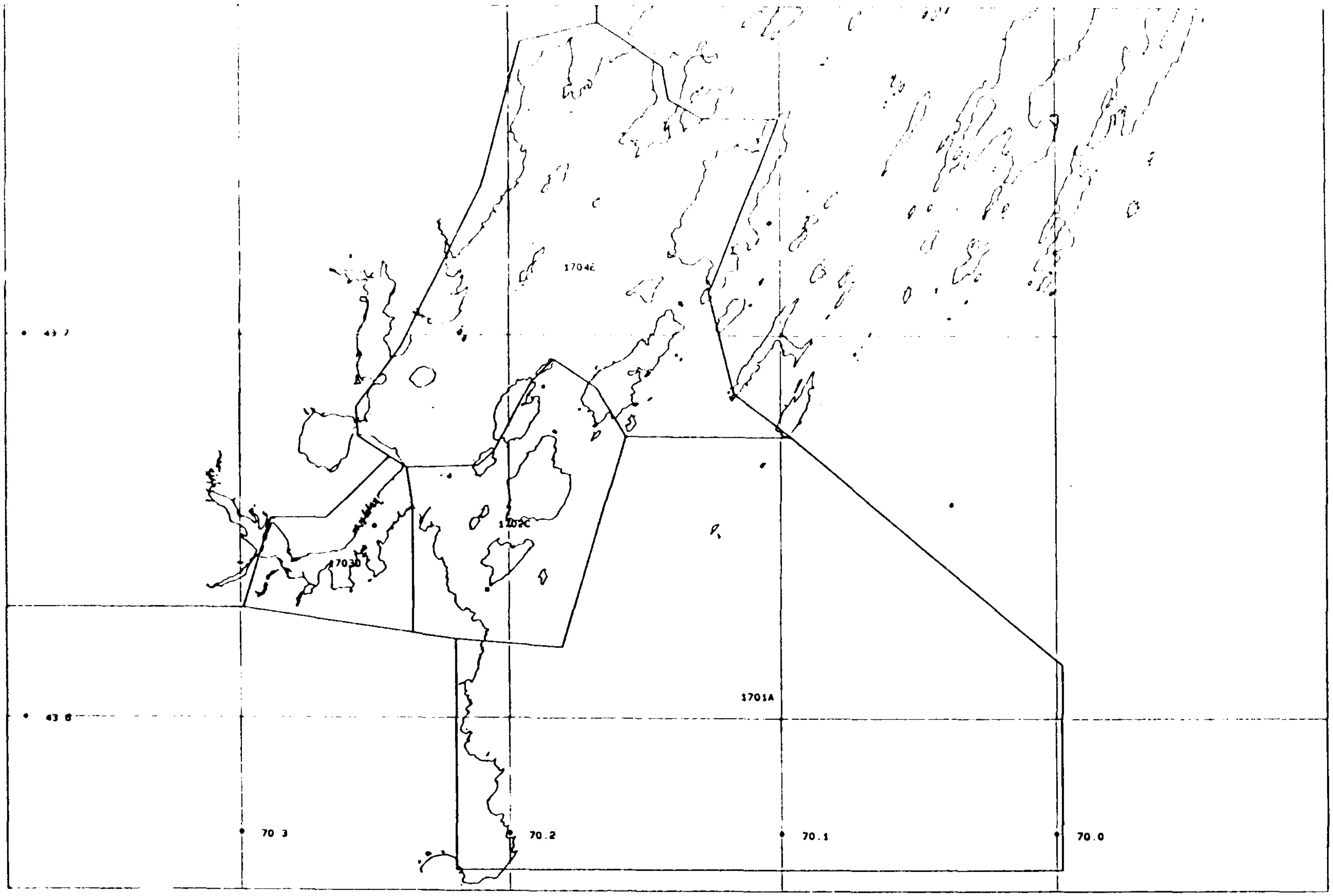
STUDY ZONE MAPS



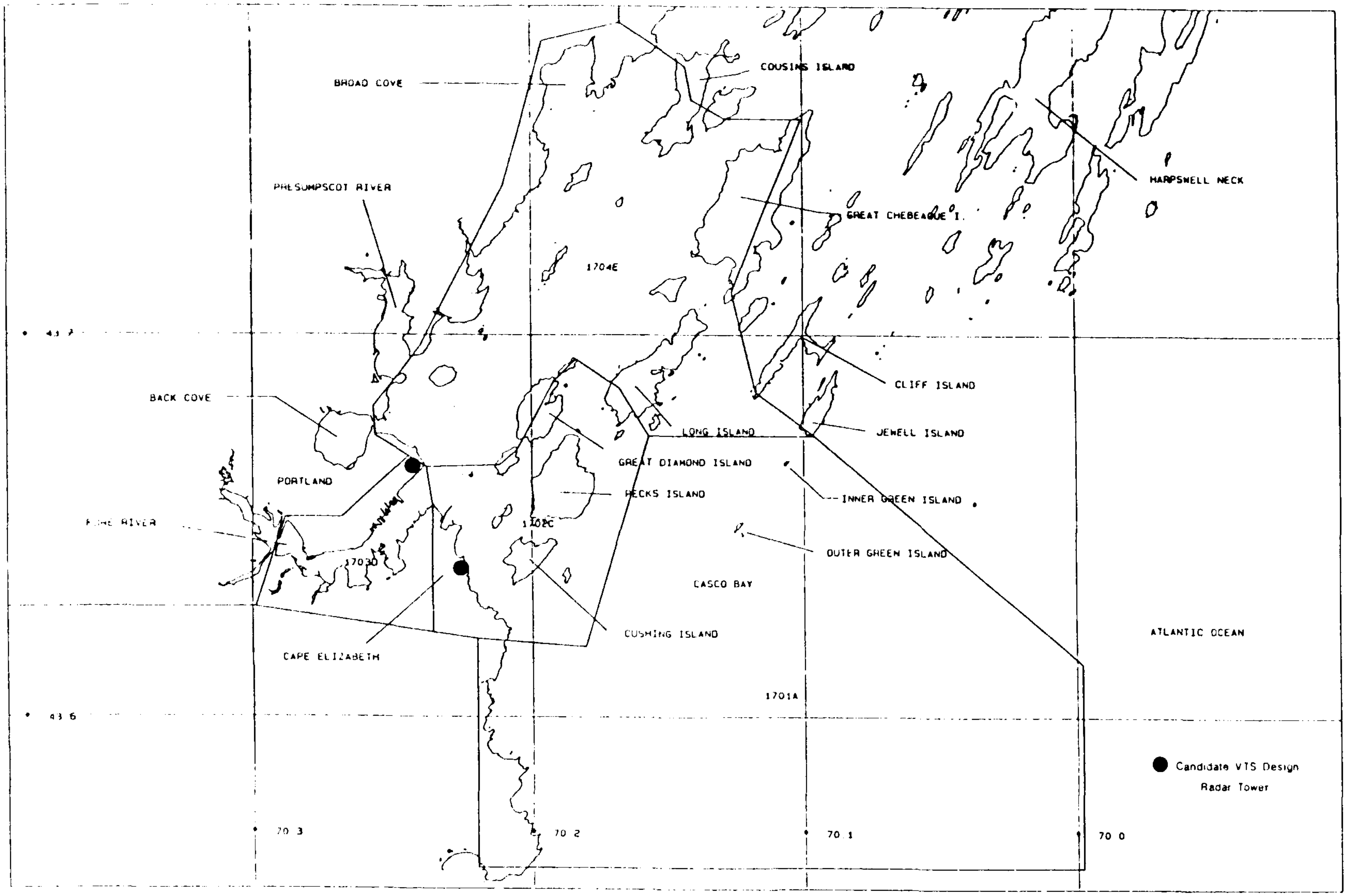
ZONE 17 - PORTLAND, ME - ZONE AND SUBZONE BOUNDARIES



ZONE 17 - PORTLAND, ME - DOMINANT VESSEL ROUTES AND COE WATERWAY CODES



ZONE 17 - PORTLAND, ME - BASE PERIOD (10 YEAR) VESSEL CASUALTIES



ZONE 17 - PORTLAND, ME - CANDIDATE VTS DESIGN RADAR LOCATIONS

CANDIDATE VTS DESIGN REPORT

FOR

PORTLAND, ME

(ZONE 17)

Prepared for:
U.S. Department of Transportation
Research and Special Programs Administration
John A. Volpe National Transportation Systems Center
Cambridge, MA 02142

Prepared by:
NAVCOM Systems, Inc.,
7203 Gateway Court
Manassas, VA 22110

July 1991

OVERVIEW

The Candidate VTS Design described in this appendix is one of 23 developed for all the study zones included in the study. This appendix documents the task performed, under Contract DTRS-57-88-C-00088 Technical Task Directive 13, as an integral part of the total Port Needs Study. The ultimate product of this task effort is an informed preliminary technical assessment of the approximate cost to the Federal Government to implement and operate a state-of-the-art VTS system. This appendix does not contain a comprehensive definition of the VTS operating requirements nor does it propose a final VTS specification suitable for implementation.

In order to consistently estimate the life cycle costs of a VTS system in each of the study zones, a "Candidate VTS Design" has been defined for each study zone using a uniform set of design criteria. Each study zone Candidate VTS Design is a composite of generic modules selected from a master list of 18 state-of-the-art surveillance modules, communications and display technology. Among the surveillance modules in the master list are several levels of technical performance from which the selection is made for application to each study subzone to address the local navigational surveillance needs and conditions. The Candidate VTS Design in each study zone represents a consistent application of the surveillance modules at the subzone level. The subzone surveillance technology is subsequently integrated into a total system for the study zone via state-of-the-art communications and display consoles at the Vessel Traffic Center (VTC) in each zone.

The application of the surveillance modules in each subzone responds to the technical requirements of that subzone as perceived by the study team. The Candidate VTS Design represents a preliminary engineering judgement on the appropriate level of technology in each subzone. The Candidate VTS Design may be considered as an informed judgement made by the contractor study team for the sole purpose of developing cost estimates that are consistent across the 23 study zones and suitable for benefit/cost comparisons among the study zones and initial budget planning and implementation priorities. The approach used to calculate VTS system costs for all 23 study zones is found in Volume III, Technical Supplement.

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PORTLAND, MAINE VTS DESIGN

1.0 SCOPE

This report includes a port survey and a VTS design for Portland, Maine. The port survey is based on a review of all pertinent literature including navigational charts. The methodology used to produce the VTS design entails coupling the problems identified in the port survey with solutions offered by state-of-the-art technology as identified in the VTS Technology Survey, November 1990. When possible, technological advances which permit manpower reductions are applied. Not all VTS problems are amenable to strictly technological solutions; some require changes in procedures and/or enforcement. These situations are identified where they occur.

2.0 PORTLAND, MAINE PORT SURVEY

2.1 INTRODUCTION

This survey report is based exclusively upon review of available literature and examination of the charts for the area and its approaches. The information thus gained has been evaluated and interpreted based upon the Survey Team's experience as professional mariners and in vessel traffic management systems.

The Survey Area includes the Port of Portland, Maine and its seaward approaches.

Although small in volume of cargo handled, 80% of that which does move through the port consists of crude oil and petroleum products. Although an exceptionally good harbor, the entrance offers significant hazards and the character of the bottom is generally hard.

The area's primary industry is the summer tourist trade and would be significantly degraded by a major spill.

2.2 OVERVIEW OF THE PORT

Climate within the Survey Area is typically Northern New England, with pleasant summers and falls, severe winters and disagreeable springs. Prevailing winds are southerly during the summers, northerly in winters. Fogs occur most frequently during June, July and August and, although a Climatological Table is not included for Portland in the Coast Pilot, it is estimated that reduced visibility occurs during a portion of the day at least 50% of the time as a year-round average (based upon data for Brunswick).

The diurnal tidal range is 9.1 feet. The velocity at strength of the tidal currents is about one knot southwestward of Cushing

Island and Diamond Island Ledge. Within the Inner Harbor itself maximum velocities are about 0.5 knot.

The main entrance to Portland is from the southward, between Ram and Cushing Islands on the north and Portland Head on the south. Depths of 40 feet or more can be taken well into the outer harbor to the pipeline berth west of Spring Point, or to the anchorage in Diamond Island Roads.

A Federal project provides for a 45-foot channel from the sea to Fort Georges, thence 35 feet in the Inner Harbor and Fore River to a turning basin at the head of deep-draft navigation near the combination railroad and highway bridge. The Project also provides a 45-foot anchorage in Diamond Island Roads and a 30-foot anchorage off Fish Point.

Numerous isolated dangers are located in the approaches, but are generally well marked. West Cod Ledge is a 6.5 mile long area of broken ground and isolated shoals, and sets across the entrance. A second line of barrier shoals extends from Ram Island Ledge to Cape Elizabeth. Major hazards, and the channel itself, are well marked by buoys and there are good fixed navigational aids including an entrance range light leading between Jordan Reef and Witch Rock. Loran-C coverage of the approach is good.

The COLREGS Demarcation Line is a line drawn between Portland Head Light, Ram Island Ledge Light and Outer Green Island.

Pilotage is compulsory for all foreign-flag ships and U. S.-flag ships under register in the foreign trade drawing over nine feet, and optional for U. S.-flag ships in the coastwise trade with a federally licensed pilot on board. Pilot service is provided by the Portland Pilots, who board inbound ships in the vicinity of Portland Lighted Horn Buoy P.

Pilots maintain station only by prior arrangement, which must be made by agents 48 hours in advance of arrival, with Estimated Times of Arrival (ETA) updated 24 hours prior to arrival. The pilot office monitors VHF-FM Channels 11 and 16, as does the pilot boat while underway. The pilot boat uses CH11 as a working frequency.

Portland Outer Harbor comprises the area westward of Cushing, Peaks, House and Great and Little Diamond Islands from the entrance at Portland Head to the entrance of Fore River at Fish Point, including the three deepwater general anchorages and the oil discharging berth westward of Spring Point. The inner harbor consists of two parts: the Main Harbor, extending from the entrance of Fore River to the Portland Bridge; and Fore River, from the Portland Bridge to the head of deep-draft navigation.

Portland is an important manufacturing, fishing and industrial center with excellent deep water facilities. These include several petroleum terminals, a general cargo terminal and one international ferry terminal. See U. S. Army Corps of Engineers Port Report Series, Report No. 1, for details.

2.3 EXISTING TRAFFIC MANAGEMENT

2.3.1 Traffic Separation Scheme (Portland)

A Traffic Separation Scheme (TSS) has been established for the safety of traffic entering and leaving Portland. The TSS consists of directed traffic lanes each with one-way inbound and outbound traffic lanes separated by a defined separation zone, and a precautionary area. The Scheme is designed for deep-draft traffic but not necessarily tugs, tows and other small vessels which usually operate outside of shipping lanes or close inshore. Refer to charts 13260 and 13286, and the Coast Pilot (Reference 1).

2.3.2 Security Broadcast System, Portland Harbor

The U. S. Coast Guard Captain of the Port (COTP) has established a voluntary system of radiotelephone broadcast and reporting procedures designed to give masters and pilots real-time information about traffic in Portland Harbor. All vessels subject to the Bridge-to-Bridge Radiotelephone Act are urged to participate. All participating vessels are asked to establish a listening watch on VHF-FM Channel 13 30 minutes prior to getting underway or, in the case of inbound ships, 30 minutes prior to arrival in the vicinity of Portland Lighted Horn Buoy P. Security calls on Channel 13 are to be made as follows:

Outbound ships:

15 Minutes prior to getting underway.

When getting underway, announcing route.

Inbound ships:

When passing Portland Lighted Horn Buoy P.

If not passing Portland Lighted Horn Buoy P, then 15 minutes prior to passing Willard Rock, Witch Rock or entering Hussey Sound.

When passing Willard Rock Lighted Gong Buoy 7, Witch Rock Lighted Buoy 2 or Hussey Sound Lighted Gong Buoy 3, announcing destination.

When passing Spring Point Ledge Light.

When passing Portland Bridge.

When anchoring or mooring.

Calls should be made at more frequent intervals in close weather. Coast Guard Group Portland monitors Channel 13 and will receive and transmit information when necessary. Refer to the Coast Pilot (Reference 2) for additional details.

2.3.3 Speed Limits

The Portland Board of Harbor Commissioners has established speed regulations for Portland Harbor consisting of the designation of "Restricted Speed Areas" and "Restricted Wake Areas". Within the "Restricted Speed Areas" vessels must limit their speeds to five miles per hour and in the "Restricted Wake Areas" may leave no wake which will cause damage to wharfs, floats, moored boats, etc. While generally aimed at small craft operation, ships operating in the Inner Harbor may be affected. Refer to the Coast Pilot (Reference 3) for specific details.

2.3.4 Anchorages

Three Federal Anchorages have been established within the Portland Harbor area. Anchorage A, west of Fort Georges, is a general anchorage to which no restrictions apply. Anchorage B, in Diamond Island Roads, is intended for general use, but especially by oil tankers and other large deep-draft ships entering port during darkness and awaiting daylight to proceed to dock. It also serves as the quarantine anchorage. Anchorage C, between Peaks and House Islands, is intended for small vessels and temporary use only.

2.4 VESSEL TRAFFIC

In 1987, Portland handling 9.2 million tons of cargo, 3.5 million tons of which were crude oil and 4.0 million tons petroleum product (Fuel oil, gasoline and jet fuel). 940 tank ship movements occurred in 1987, coupled with 511 barge movements (Reference 4).

General cargo traffic may be considered light, since Portland maintains only one deep-draft cargo facility. Fishing and recreational traffic in and around Portland proper is not heavy and tends to be seasonal.

2.5 ENVIRONMENTAL SENSITIVITY

The entire Casco Bay shoreline must be considered environmentally sensitive, with pollution potentially impacting heavily upon seasonal recreational use (the region's major industry) and the

quality of life of residents. Pollution would also threaten the valuable lobster fishery and the aquatic birds whose habitat is the shoreline/island areas.

A "worse case" situation is a major spill of crude oil at or near Fish Point on a flood tide and strong southerly wind. This would pollute, unless immediately contained, the inner bay area and attendant shoreline to Brunswick and the islands within the bay.

2.6 PORT SUB-ZONES

The Study Area was examined to determine appropriate sub-zones, using the methodology based upon the "confined-complex", "open-complex", "confined-simple" and "open-simple" system employed by the Canadian VTS Study in 1984 (Reference 5). Briefly stated, "open" and "confined" address the influence of geography upon a ship's ability to maneuver; and "simple" vs "complex" is descriptive of the nature of the interactions between ships within those geographic areas. This basic matrix was overlaid by a subjective assessment of appropriate traffic management/risk amelioration measures in order to derive sub-zones within which VTS needs are homogeneous, or nearly so.

2.6.1 Sub-Zone I -- OFFSHORE APPROACHES (NOAA Charts 13288 & 13286)

The sub-zone lies seaward of a line drawn from the shore along 43^0-25'N to 69^0-50'W, thence north to 43^0-40'N, and then west to the shoreline.

The sub-zone functions essentially as a data catchment area for shipping entering Portland from the sea. The principal function of the VTS within the sub-zone is to establish communications with inbound traffic and obtain information about characteristics, intentions and movements.

The sub-zone is "open-simple."

2.6.2 Sub-Zone II -- PORTLAND ENTRANCE (NOAA Chart 13292)

The sub-zone lies between the inshore limits of Sub-Zone I (a line drawn from the shore along 43^0-25'N to 69^0-50'W, thence north to 43^0-40'N, and then west to the shoreline) and a line connecting Cape Elizabeth Light, Outer Green Island and the south end of Cushing Island.

The sub-zone encompasses all of the Portland TSS Precautionary Area, the pilot boarding area and the approach to Portland Harbor itself. There are significant navigational hazards in the southwestern portion of the sub-zone. The VTC should be capable of providing both navigational assistance and movement management advice.

The sub-zone is "confined-simple."

2.6.3 Sub-Zone III -- PORTLAND (NOAA Chart 13292)

The sub-zone consists of the waterways inshore of Sub-Zone II (a line connecting Cape Elizabeth Light, Outer Green Island and the south end of Cushing Island), and south of a line between the north end of Little Diamond Island and Martin Point. It includes the Fore River to the Dual Bridge and Back Bay.

The sub-zone contains several anchorages which may require management from time to time as well as the waterways serving facilities in Portland Harbor. Movement management advice is required, and the VTS should be prepared to provide navigational assistance to vessels in the vicinity of Portland Head.

The sub-zone is "confined-complex."

2.7 PROBLEM AREA IDENTIFIERS

2.7.1 PAI II-1. West Cod Ledge (NOAA Chart 13288)

West Cod Ledge represents a line of navigational dangers which, although individually well-marked, can pose a hazard to deep-draft ships particularly in foul weather and poor visibility. Shoal-draft traffic entering Portland from or destined for ports to the south tends to run inshore of West Cod Ledge, potentially making it difficult during low visibility to identify on radar the buoys marking the various dangers.

The VTS should be capable of providing navigational assistance to vessels in the vicinity of the dangers.

2.7.2 PAI III-1. Portland Head (NOAA Chart 13292)

Deep-draft traffic entering or leaving Portland must make a significant course alteration east of Portland Head, at a point where inbound shoal-draft traffic consisting of tugs and tows tends to merge with the deep-draft routes.

Outbound deep-draft ships over-running the turning point can place themselves at hazard from Jordan Reef and the 31-foot spot between it and Portland Head. Inbound, over-running the turning point will place a ship in the outbound traffic area and, potentially, at hazard from Portland Head itself. Some interference is possible between differing types of traffic in this area because of the merging of deep- and shoal-draft traffic.

The VTS should be capable of providing both navigational assistance and movement management advice.

2.7.3 PAI III-2. Fish Point (NOAA Chart 13292)

The area southeast of Fish Point requires a major alteration of course, occurring at a point where minor traffic enroute to and from Portland, can create a degree of congestion. It is not unusual for tugs to transfer barges between towline and alongside positions in this area as well. Depending upon anchorage use, ships present in the anchorage can effectively limit the area available for maneuvering.

Because the area is well marked and distances are short, it is unlikely that navigational assistance would be required even during fog, but the VTS should be prepared to provide movement management advice.

3.0 PORTLAND VTS DESIGN

3.1 INTRODUCTION

A detailed survey of the Port of Portland, Maine is the basis for this design. An approach to costing VTS systems is outlined in Vol. III, Technical Supplement and a method of categorizing surveillance sensors into "modules" has also been developed. These modules are defined in terms of cost and performance and are to be applied to all VTS designs in this study. The applicability of Automatic Dependent Surveillance (ADS) technology is also discussed in this report. The three sub-zones defined in the harbor survey remain the same.

Traffic management requirements for each sub-zone are developed from PAI analysis. Table 3-1 lists in tabular form a summation of the problems identified and the management required by sub-zone.

The hardware and software selected for this design provide the level of surveillance justified by the problems identified in each sub-zone. A secondary consideration is to locate all VTS assets so that they are sufficient for the sub-zone in question and can contribute to adjoining sub-zones to achieve maximum usage. All specific equipments are then selected based on perceived surveillance requirements and overall VTS system architecture.

3.1.1 VTS Design Approach

The choice of surveillance sensors is dependent on the VTS mission. For the purposes of this design, the VTS mission is defined as that which insures the safety of navigation and the protection of the environment. In order to accomplish this mission, mandatory participation of all vessels over 20 meters is essential. The Vessel Traffic Center (VTC) must provide

TABLE 3-1. PORTLAND, ME PROBLEM AREA IDENTIFIERS

PAI	LOCATION	PROBLEM	MANAGEMENT
I	Offshore Approaches	Data catchment area for inbound shipping	Have real-time knowledge of vessel movements, locations through reporting. Enter inbound shipping information into database.
II	Portland Entrance	Navigational hazards, potential congestion.	Have real-time knowledge of vessel movements, locations. Provide navigational assistance and movement management advice.
III	Portland Harbor	Navigational hazards, potential congestion and difficult meetings. Anchorages require management.	Have real-time knowledge of vessel movements and locations. Provide movement management advice, navigational assistance and manage anchorages.

navigation safety advice to all vessels. The VTS in the United States will have no facilitation of commerce role nor will it offer piloting assistance of any kind.

The primary criteria for selection of adequate surveillance sensors are:

- o Percentage of vessels of the desired minimum size detected in designated surveillance areas
- o Percentage of lost tracks
- o Accuracy of the position and track obtained
- o Reliability of the surveillance system
- o Timeliness of the data obtained
- o Ability to interpret and use the data obtained

Secondary criteria are:

- o Cost of the VTS system -- reduction of manpower by the use of technology
- o Expandability -- increased VTS responsibility, area, and/or support of other missions

Active surveillance sensors including radar, communications, and closed circuit television (CCTV) installations are used when detection and tracking of vessels is paramount to providing safety advice. These devices are considered fail safe in that it is known with certainty when they have failed. The performance characteristics of these sensors are known from operational VTS worldwide experience. In this design they are selected to assure that the necessary operational criteria identified for each sub-zone is realized.

Many dependent surveillance techniques are possible. These range from voice radio reporting of required VTS data to automatic position and identification recording devices that can be interrogated from shore known as Automatic Dependent Surveillance (ADS) devices. The position and/or movement reporting form of dependent surveillance is used extensively in existing VTS systems. The major regions of current use are those which do not require active surveillance. To apply ADS technology to a specific sub-zone within a VTS zone the following additional criteria must be considered:

- o The number and class of vessels interacting in the sub-zone and which of these interactions are important to the VTS mission. Obviously all vessel classes of interest must be appropriately equipped. This requires that all vessels

of the classes selected which will ever pass through this sub-zone must be equipped with an ADS device. This requirement to detect so many different vessels argues against the use of ADS. In areas where only one class of vessel is of interest, ADS is more easily implemented.

o The interactions or transits to be monitored must not demand that the surveillance be fail safe, i.e. positively detecting failures. This type of surveillance is related to position reporting in that it may not always function or be used properly and the VTS has limited control over its operation.

o It must be determined that if active surveillance is not justified, the additional information obtained from ADS over position reporting is necessary.

o If the class or group of vessels to be monitored is a "controllable" group, ADS can be easily implemented and satisfactory operation more readily achieved. Controllable means a clearly defined subset of vessels, e.g. a specific barge company; vessels carrying a specific cargo, etc.

o The number of different vessels in each class of interest that passes through the sub-zone in question must be determined. This number must be known to accurately estimate the cost of selecting this option for this sub-zone.

o A specific ADS solution for one sub-zone in one harbor may affect all the VTS designs for all the other sub-zones in all the other harbors.

3.1.2 Assumptions

The design of a VTS system for the Portland VTS zone starts with a set of assumptions based on the detailed survey and other data. These assumptions are as follows:

o As recommended by the IMO, all vessels of 20 meters or more in length are required to participate in the VTS. Participation is defined (at a minimum) as monitoring the VTS frequency and reporting as required.

o The VTS system is implemented with the cooperation and assistance of the port authorities, pilots associations, and marine exchange, if any. The existing facilities, services, and procedures established and operated by these organizations are major elements of an integrated VTS system as defined in the IMO VTS Guidelines.

o The life-cycle of all system hardware is ten years.

3.2 DESIGN DECISIONS (FIGURE 3-1)

3.2.1 General

Examination of the traffic levels, geographical features and identified problem areas in this port leads to the overall conclusion that one control sector managed by one watchstander is sufficient.

3.2.2 Hardware Location and Selection

3.2.2.1 Sub-Zone III

Cape Elizabeth Site	1 Module 1 radar 1 Module 10 VHF 1 Module 13 MET
Portland Site	1 Module 1 radar 1 Module 10 VHF 1 Module 11 VHF

3.2.3 Vessel Traffic Center

The design of the hardware and software should be modern and capable of operating with reduced staff levels and no loss of effectiveness. One watchstander with an integrated data workstation and decision aiding software can effectively manage the activity in this port. This Vessel Traffic Center concept demands that the watchstander be separated from any other harbor/port information requests. The Center must be structured so that such requests are controlled by a bulletin board type interface. One officer-in-charge and one clerk are also required for the proper administration of the facility.

The Vessel Traffic Center is located in Portland in a location with good visual surveillance of the port. The center is to employ the following equipment:

3.2.3.1 VTS Console

This console provides total data integration from all sensors in all sectors. These data are graphically shown on raster scan, high light level, color displays. A data display is also provided. Console design architecture is general purpose computer based, open architecture, bus organized, allowing operation of the system as a local area network (LAN). Data interchange with other facilities by modem is provided as well as interface with the U.S. Coast Guard standard terminal. The design allows board level modification and expansion. Features of the software and hardware provided are:

Surveillance Modules -Sub Zones	RADAR						ADS			VHF		MET.		HYD.		DF	CCTV		COMMENTS
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
I																			Comms coverage from Sub-Zone III
II																			Radar/Comms coverage from Sub-Zone III
III	2									2	1		1						

FIGURE 3-1. PORTLAND, ME SURVEILLANCE SURVEY

o Software written in a high level language.

o Software providing the total integration of data from all VTS sensors.

o Layering of data in at least four layers to be operator selectable.

o The ability to sector data including sector to sector handoff of targets.

o The ability to accept external digital data derived from transmissions of shipboard transponders or other sources and integrate the information with all other sensor data.

o Automatic and/or manual acquisition of radar targets including automatic tracking and target ID assignments. Guard zones with automatic acquisition of all targets entering the zone.

o Several warning levels of vessel interaction designed to direct attention to developing situations rather than a simple CPA alarm strategy.

o Complete vessel monitoring and alarm capability including anchor watch, CPA, TCPA, track history, adjustable target velocity vectors, restricted area penetration and maneuvering monitor is provided. Additional warning and/or alarm features allowed by programming changes in high level language.

o Complete modern color graphics capability with offset and zoom

o Complete harbor navigation aid monitoring capability including buoy position, light status, etc.

o Remote control of all radars and radar interfaces as well as radar data processing including site-to-site integration, clutter suppression, scan conversion and target extraction.

o Complete track projection capability which can predict and/or analyze future interactions based on current position, destination and velocity.

o The capability of constructing a complete vessel data base and interfacing it to the real-time data display from the VTS sensors.

3.2.3.2 Communications Console

This console is capable of remotely operating the proposed transmitting/receiving sites and allowing transmission and monitoring on all required frequencies. The console provides two operating positions each to be capable of complete communications control. It is capable of modular expansion if other remote communications sites are added.

3.2.3.3 Supervisor Control and Data Acquisition (SCADA) Equipment

A SCADA capability is provided to the major module level at remote sites so that the watchstander can determine the status of the entire VTS system. A graphic readout is provided in block diagram form indicating operational status of all elements in the system. Security monitoring of remote sites is also included.

3.2.3.4 Recording Equipment

Time synchronized video and audio recording equipment is to be provided. This equipment is capable of recording and playing back the data presented to the VTS watchstander and his reaction to the situation. An extra set of recording equipment is to be installed for redundancy purposes.

3.3 COST ESTIMATES

3.3.1 General

Vol. III, Technical Supplement discusses a generalized approach to estimating VTS system costs. This approach is based on interviews with system designers and purchasers of recently constructed systems. The cost of the Portland VTS system has been estimated using this approach and is detailed below. The assumptions made in estimating these costs are listed in Paragraph 3.1.2.

3.3.2 Hardware (x $1000)

Vessel Traffic Center	non-recurring	recurring(10-yr)
VTS Console (1 workstation one supervisory console & all software)	500	
Communications console	100	
Recording Equipment	50	
SCADA Equipment (2 radar sites)	200	
Sub-total:	850	400

Sub-Zone I--Offshore Approaches (NOAA Charts 13288 & 13286)

Comms coverage from Sub-Zone III.

Sub-Zone II--Portland Entrance (NOAA Chart 13292)

Radar/comms coverage from Sub-Zone III.

Sub-Zone III--Portland (NOAA Chart 13292)

2 Module 1 radars	620	620
2 Module 10 VHF	39	26
1 Module 11 VHF	48	20
1 Module 13 MET	40	5
Sub-total:	747	671
HARDWARE TOTALS:	1597	1071

3.3.3 Project Totals (x $1000)

Non-recurring

Hardware	$1597
Management, Engineering, etc. (50%) Assumptions: Turnkey system, Procurement by integ.contractor, good manufacturer support, some software provided, System Manual required	800
Installation site integration (20%) Assumptions: Complete installation by contractor, remote access no serious problem, many widespread sites	320
Spares & Training (10%)	160
Civil Engineering 2 remote radar sites, a VTC in Portland, remote comms and WX sensors installations, land acquisition	1500
PROJECT ESTIMATE:	4377
Data Base Management System	300
TOTAL: (non-recurring)	$4677

Recurring (10 year)

Hardware	1071
1 Watchstander x 5 = 5 man/years @ 50K x 10	2500
1 Officer-in-Charge	500
1 Clerk	500
TOTAL: (recurring) (10-year life)	$ 4571
TOTAL 10-YEAR PROJECT COST:	$ 9248

REFERENCES

1. United States Coast Pilot, Volume 1, Atlantic Coast: Eastport to Cape Cod, 25th Edition, NOAA, Washington, D.C., 1989, p. 159.

2. Ibid, pp. 160-161.

3. Ibid, pp. 162-163.

4. Summary Statistics on Leading U.S. Ports, Center for Marine Conservation, Washington, D.C. 1990.

5. Final Report, National Vessel Traffic Services Study (TP5964E), Canadian Coast Guard, Ottawa 1984, pp. 89-91.

GLOSSARY

ADS: Automatic Dependent Surveillance

ARPA: Automatic Radar Plotting Aid.

"CONFINED-COMPLEX": a combination of terms relating to the geography and the nature of the interactions between ships. See Final Report National Vessel Traffic Services Study (TP-5965E), Canadian Coast Guard, Ottawa, October 1984, pp.89-91.

"CONFINED-SIMPLE": a combination terms relating to the geography and the nature of the interactions between ships. See Final Report National Vessel Traffic Services Study (TP-5965E), Canadian Coast Guard, Ottawa, October 1984, pp.89-91.

COTP: Captain of the Port

CCTV: closed circuit television

COLREGS LINE: a demarcation line delineating those waters upon which international regulations for the prevention of collisions at sea apply.

CPA: closest point of approach

DBMS: data base management system

DF: direction finder

FAA: Federal Aviation Administration

GIS: Geographic Information System

ICW: Intracoastal Waterway

IMO: International Maritime Organization

KW: Kilowatt

LAN: local area network

LLOYD'S LIST: a listing of all merchant vessels of the world including their physical characteristics. Published by Lloyd's of London.

LNG: liquified natural gas

NOAA: National Oceanic and Atmospheric Administration

"OPEN-COMPLEX": a combination of terms relating to the geography and the nature of the interactions between ships. See Final Report National Vessel Traffic Services Study (TP-5965E), Canadian Coast Guard, Ottawa, October 1984, pp. 89-91.

"OPEN-SIMPLE": a combination of terms relating to the geography and the nature of the interactions between ships. See Final Report National Vessel Traffic Services Study (TP-5965E), Canadian Coast Guard, Ottawa, October 1984, pp. 89-91.

PAI: Problem Area Identifier

PRECAUTIONARY AREA: an area normally an intersection, entrance to, or exit from a traffic separation scheme where vessel interactions are unpredictable

SCADA: Supervisor Control and Data Acquisition

TCPA: time of closest point of approach

TRAFFIC SEPARATION SCHEME: routes incorporating traffic separation to increase the safety of navigation, particularly in converging areas of high traffic density.

VHF: very high frequency

VTC: vessel traffic center

VTS: vessel traffic services

STUDY ZONE INPUT DATA AND OUTPUT STATISTICS

Appendix Q Zone 17 Portland, ME

TABLE 1 Assignment of COE Waterway Codes to Subzones 8/06/91

COE Waterway		Name
Subzone 1701A		
128	A	PORTLAND HARBOR, MAINE
Subzone 1702C		
128	A	PORTLAND HARBOR, MAINE
Subzone 1703D		
128	A	PORTLAND HARBOR, MAINE

TABLE 2 Base Year 1987 Cargo Tons by Subzone, Commodity, and Vessel Type

Subzone 1701A

Comm. Code	Name	Dry Cargo	Tanker	Dry Cargo Barge Tow	Tanker Barge Tow	Total
3	FISHERIES PRODUCTS	76	0	0	0	76
4	MINING PRODUCTS, NEC	127,160	0	0	0	127,160
5	PROC. FOODS & MFTRS, NEC	179,427	0	100	0	179,527
6	WASTE OF MANUFACTURING	40,025	0	0	0	40,025
1311	CRUDE PETROLEUM	0	3,111,920	0	397,609	3,509,529
2871	NITROGEN CHEM FERTILIZER	0	20,029	0	2,559	22,588
2911	GASOLINE, INCL NATURAL	0	1,588,790	0	217,888	1,806,678
2912	JET FUEL	0	31,982	0	4,086	36,068
2913	KEROSENE	0	67,820	0	9,589	77,409
2914	DISTILLATE FUEL OIL	0	1,195,974	0	205,922	1,401,896
2915	RESIDUAL FUEL OIL	0	737,954	0	134,175	872,129
2916	LUBRIC OILS-GREASES	0	926,647	0	118,397	1,045,044
	Subzone Total :	346,688	7,681,116	100	1,090,225	9,118,129

Subzone 1702C

Comm. Code	Name	Dry Cargo	Tanker	Dry Cargo Barge Tow	Tanker Barge Tow	Total
3	FISHERIES PRODUCTS	76	0	0	0	76
4	MINING PRODUCTS, NEC	127,160	0	0	0	127,160
5	PROC. FOODS & MFTRS, NEC	179,427	0	100	0	179,527
6	WASTE OF MANUFACTURING	40,025	0	0	0	40,025
1311	CRUDE PETROLEUM	0	3,111,920	0	397,609	3,509,529
2871	NITROGEN CHEM FERTILIZER	0	20,029	0	2,559	22,588
2911	GASOLINE, INCL NATURAL	0	1,588,790	0	217,888	1,806,678
2912	JET FUEL	0	31,982	0	4,086	36,068
2913	KEROSENE	0	67,820	0	9,589	77,409
2914	DISTILLATE FUEL OIL	0	1,195,974	0	205,922	1,401,896
2915	RESIDUAL FUEL OIL	0	737,954	0	134,175	872,129
2916	LUBRIC OILS-GREASES	0	926,647	0	118,397	1,045,044
	Subzone Total :	346,688	7,681,116	100	1,090,225	9,118,129

Subzone 1703D

Comm. Code	Name	Dry Cargo	Tanker	Dry Cargo Barge Tow	Tanker Barge Tow	Total
3	FISHERIES PRODUCTS	76	0	0	0	76
4	MINING PRODUCTS, NEC	127,160	0	0	0	127,160
5	PROC. FOODS & MFTRS, NEC	179,427	0	100	0	179,527
6	WASTE OF MANUFACTURING	40,025	0	0	0	40,025
1311	CRUDE PETROLEUM	0	3,111,920	0	397,609	3,509,529
2871	NITROGEN CHEM FERTILIZER	0	20,029	0	2,559	22,588
2911	GASOLINE, INCL NATURAL	0	1,588,790	0	217,888	1,806,678
2912	JET FUEL	0	31,982	0	4,086	36,068
2913	KEROSENE	0	67,820	0	9,589	77,409
2914	DISTILLATE FUEL OIL	0	1,195,974	0	205,922	1,401,896
2915	RESIDUAL FUEL OIL	0	737,954	0	134,175	872,129
2916	LUBRIC OILS-GREASES	0	926,647	0	118,397	1,045,044
	Subzone Total :	346,688	7,681,116	100	1,090,225	9,118,129

Appendix Q ZONE 17 Portland, ME *7/22/91*

TABLE 3 Base Year (1987)
Vessel Transits by Subzone, Vessel Type, and Size.

Vessel Type	Large	Medium	Small	Total
Subzone : 1701A				
Passenger	0	0	1,824	1,824
Dry Cargo	20	77	19,593	19,690
Tanker	92	116	181	389
Dry Cargo Barge Tow	9	0	10	19
Tanker Barge Tow	180	0	331	511
Tug/Tow Boat	0	0	519	519
Subzone Total:	301	193	22,458	22,952
Subzone : 1702C				
Passenger	0	0	18,292	18,292
Dry Cargo	20	77	19,593	19,690
Tanker	92	116	181	389
Dry Cargo Barge Tow	9	0	10	19
Tanker Barge Tow	180	0	331	511
Tug/Tow Boat	0	0	519	519
Subzone Total:	301	193	38,926	39,420
Subzone : 1703D				
Passenger	0	0	14,540	14,540
Dry Cargo	20	77	19,593	19,690
Tanker	92	116	181	389
Dry Cargo Barge Tow	9	0	10	19
Tanker Barge Tow	180	0	331	511
Tug/Tow Boat	0	0	519	519
Subzone Total:	301	193	35,174	35,668
Subzone : 1704E				
Passenger	0	0	20,796	20,796
Subzone Total:	0	0	20,796	20,796

Note: Sum of all vessel transits within each study subzone.

7/22/91

Appendix Q ZONE 17 Portland, ME

TABLE 3 Base Year (1987)
Vessel Transits by Suzone, Vessel Type, Size.

ZONE TOTALS

ZONE 17 Portland, ME

Vessel Type	Large	Medium	Small	Total
Passenger	0	0	33,666	33,666
Dry Cargo	20	77	19,593	19,690
Tanker	92	116	181	389
Dry Cargo Barge Tow	9	0	10	19
Tanker Barge Tow	180	0	331	511
Tug/Tow Boat	0	0	519	519
Zone Total:	301	193	54,300	54,794

Note: Sum of all arrivals/departures to/from all terminals within the Study Zcne.

Appendix Q Zone 17 Portland, ME

TABLE 4 Barges Per Tow - Average Factors by COE Waterway 8/6/91

COE Code	Waterway Name	Dry Barge	Tank Barge
SUBZONE	All Subzones within this Zone	1	1

NOTE: Average size of tows arriving/departing terminals within the waterway. Sizes of other tows transiting the area may differ.

Appendix Q Zone 17 Portland, ME

TABLE 5 Other Local Vessels by Subzone 7/21/91

Subzone	Name	Number of Vessels	Vessels per Square Mile
1701A		4,411	68.92
1702C		12,018	1,238.97
1703D		12,018	6,676.67
1704E		7,607	217.34
	Total for Zone	36,054	326.28

Note: ' ate registered (1989/90) vessels estimated to be operated w ·hin the Subzone.

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Appendix Q ZONE 17 Portland, ME

TABLE 6.1 Forecast 1995
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 1701A				
Passenger	0	0	1,860	1,860
Dry Cargo	28	115	24,500	24,643
Tanker	108	130	204	442
Dry Cargo Tow	0	0	12	12
Tanker Tow	210	0	379	589
Tug/Tow Boat	0	0	634	634
Subzone Total:	346	245	27,589	28,180
Subzone : 1702C				
Passenger	0	0	18,651	18,651
Dry Cargo	28	115	24,500	24,643
Tanker	108	130	204	442
Dry Cargo Tow	0	0	12	12
Tanker Tow	210	0	379	589
Tug/Tow Boat	0	0	634	634
Subzone Total:	346	245	44,380	44,971
Subzone : 1703D				
Passenger	0	0	14,826	14,826
Dry Cargo	28	115	24,500	24,643
Tanker	108	130	204	442
Dry Cargo Tow	0	0	12	12
Tanker Tow	210	0	379	589
Tug/Tow Boat	0	0	634	634
Subzone Total:	346	245	40,555	41,146
Subzone : 1704E				
Passenger	0	0	21,205	21,205
Subzone Total:	0	0	21,205	21,205

Note: Sum of all vessel transits within each study subzone.

TABLE 6.2 Forecast 2000
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 1701A				
Passenger	0	0	1,896	1,896
Dry Cargo	35	152	28,630	28,817
Tanker	124	139	216	479
Dry Cargo Tow	0	0	14	14
Tanker Tow	237	0	419	656
Tug/Tow Boat	0	0	736	736
Subzone Total:	396	291	31,911	32,598
Subzone : 1702C				
Passenger	0	0	19,018	19,018
Dry Cargo	35	152	28,630	28,817
Tanker	124	139	216	479
Dry Cargo Tow	0	0	14	14
Tanker Tow	237	0	419	656
Tug/Tow Boat	0	0	736	736
Subzone Total:	396	291	49,033	49,720
Subzone : 1703D				
Passenger	0	0	15,117	15,117
Dry Cargo	35	152	28,630	28,817
Tanker	124	139	216	479
Dry Cargo Tow	0	0	14	14
Tanker Tow	237	0	419	656
Tug/Tow Boat	0	0	736	736
Subzone Total:	396	291	45,132	45,819
Subzone : 1704E				
Passenger	0	0	21,621	21,621
Subzone Total:	0	0	21,621	21,621

Note: Sum of all vessel transits within each study subzone.

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Appendix Q ZONE 17 Portland, ME

TABLE 6.3 Forecast 2005
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 1701A				
Passenger	0	0	1,941	1,941
Dry Cargo	44	203	33,921	34,168
Tanker	143	150	234	527
Dry Cargo Tow	0	0	16	16
Tanker Tow	269	0	464	733
Tug/Tow Boat	0	0	869	869
Subzone Total:	456	353	37,445	38,254
Subzone : 1702C				
Passenger	0	0	19,469	19,469
Dry Cargo	44	203	33,921	34,168
Tanker	143	150	234	527
Dry Cargo Tow	0	0	16	16
Tanker Tow	269	0	464	733
Tug/Tow Boat	0	0	869	869
Subzone Total:	456	353	54,973	55,782
Subzone : 1703D				
Passenger	0	0	15,476	15,476
Dry Cargo	44	203	33,921	34,168
Tanker	143	150	234	527
Dry Cargo Tow	0	0	16	16
Tanker Tow	269	0	464	733
Tug/Tow Boat	0	0	869	869
Subzone Total:	456	353	50,980	51,789
Subzone : 1704E				
Passenger	0	0	22,134	22,134
Subzone Total:	0	0	22,134	22,134

Note: Sum of all vessel transits within each study subzone.

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Appendix Q ZONE 17 Portland, ME

TABLE 6.4 Forecast 2010
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 1701A				
Passenger	0	0	1,987	1,987
Dry Cargo	58	277	40,811	41,146
Tanker	166	161	253	580
Dry Cargo Tow	0	0	18	18
Tanker Tow	309	0	518	827
Tug/Tow Boat	0	0	1,041	1,041
Subzone Total:	533	438	44,628	45,599
Subzone : 1702C				
Passenger	0	0	19,931	19,931
Dry Cargo	58	277	40,811	41,146
Tanker	166	161	253	580
Dry Cargo Tow	0	0	18	18
Tanker Tow	309	0	518	827
Tug/Tow Boat	0	0	1,041	1,041
Subzone Total:	533	438	62,572	63,543
Subzone : 1703D				
Passenger	0	0	15,843	15,843
Dry Cargo	58	277	40,811	41,146
Tanker	166	161	253	580
Dry Cargo Tow	0	0	18	18
Tanker Tow	309	0	518	827
Tug/Tow Boat	0	0	1,041	1,041
Subzone Total:	533	438	58,484	59,455
Subzone : 1704E				
Passenger	0	0	22,659	22,659
Subzone Total:	0	0	22,659	22,659

Note: Sum of all vessel transits within each study subzone.

Appendix Q ZONE 17 Portland, ME

TABLE 6.5 Forecast 1995 - 2010 Vessel Transits by Vessel Type and Size

Vessel Type	Large	Medium	Small	Total
1995 FORECASTED ZONE TOTALS				
Passenger	0	0	34,328	34,328
Dry Cargo	27	110	23,205	23,342
Tanker	108	130	204	442
Dry Cargo Tow	0	0	12	12
Tanker Tow	210	0	379	589
Tug/Tow Boat	0	0	634	634
1995 Zone Total:	345	240	58,762	59,347
2000 FORECASTED ZONE TOTALS				
Passenger	0	0	35,002	35,002
Dry Cargo	33	141	26,254	26,428
Tanker	124	139	216	479
Dry Cargo Tow	0	0	14	14
Tanker Tow	237	0	419	656
Tug/Tow Boat	0	0	736	736
2000 Zone Total:	394	280	62,641	63,315
2005 FORECASTED ZONE TOTALS				
Passenger	0	0	35,833	35,833
Dry Cargo	41	186	30,592	30,819
Tanker	143	150	234	527
Dry Cargo Tow	0	0	16	16
Tanker Tow	269	0	464	733
Tug/Tow Boat	0	0	869	869
2005 Zone Total:	453	336	68,008	68,797
2010 FORECASTED ZONE TOTALS				
Passenger	0	0	36,683	36,683
Dry Cargo	55	254	36,806	37,115
Tanker	166	161	253	580
Dry Cargo Tow	0	0	18	18
Tanker Tow	309	0	518	827
Tug/Tow Boat	0	0	1,041	1,041
2010 Zone Total:	530	415	75,319	76,264

Note: Sum of all arrivals/departures to/from all terminals within the study zone.

Appendix Q Zone 17 Portland, ME 7/25/91

TABLE 7 Vessel Casualty History (10 Year Totals) by
Subzone, Vessel Type and Size, and Casualty Type

Vessel Type	Size	Collisions	Rammings	Groundings	Other	Total
Subzone: 1702C						
Fishing	Small	0	0	1	0	1
Subzone Totals:		0	0	1	0	1
Subzone: 1703D						
Fishing	Small	2	0	0	0	2
Subzone Totals:		2	0	0	0	2
Subzone: 1704E						
Tug/Tow Boat	Small	0	0	1	0	1
Subzone Totals:		0	0	1	0	1
Zone Totals:		2	0	2	0	4

Note: OTHER equals barge breakaways and weather caused vessel casualties.

APPENDIX TABLE Q-8 ZONE 17, PORTLAND, ME - VTS LEVELS IN OPERATION

(Not Applicable to This Sub-Zone.)

APPENDIX TABLE Q-9 ZONE 17, PORTLAND, ME
CANDIDATE VTS DESIGN - 1995-2010

UNITS		
2	Radar Module 1	- Average Performance
0	Radar Module 2	- Average Performance
0	Radar Module 3	- High Performance
0	Radar Module 4	- High Performance
0	Radar Module 5	- Special Purpose
0	Radar Module 6	- Special Purpose
0	ADS Module 7	- Active Radar Transponder (Type 1)
0	ADS Module 8	- Positional Transponder, Small Area, Very High Accuracy (Type 5)
0	ADS Module 9	- Positional Transponder, Small Area, High Accuracy (Type 6)
2	VHF Module 10	- Low power VHF Transmitting/ Receiving Facility
1	VHF Module 11	- High power VHF Transmitting/ Receiving Facility
0	Meteorological Module 12	- Air temperature, wind direction and speed
1	Meteorological Module 13	- Air temperature, wind direction and speed, visibility
0	Hydrological Module 14	- Water Temperature and Depth
0	Hydrological Module 15	- Water Temperature, Depth and Current
0	VHF/DF MODULE 16	- Line of position measurement to 2 degree RMS
0	CCTV MODULE 17	- Fixed Focus CCTV via Telephone Lines
0	CCTV MODULE 18	- Remotely Controllable CCTV via

TABLE 10A — Avoided Vessel Casualties 1996 - 2010 — 7/31/91
Candidate VTS Systems

Counts

Vessel Type	Size	Collision	Ramming	Grounding	Total
Passenger	Small	.08	.01	.09	.18
Dry Cargo	Large	.00	.00	.01	.01
Dry Cargo	Medium	.01	.00	.00	.01
Dry Cargo	Small	.37	.04	.07	.49
Tanker	Large	.03	.01	.04	.07
Tanker	Medium	.00	.00	.00	.01
Tanker	Small	.00	0.00	.00	.00
Dry Cargo Barge T	Small	.00	.00	.00	.00
Tanker Barge Tow	Large	.01	.01	.01	.03
Tanker Barge Tow	Small	.03	.01	.02	.06
Tug/Tow Boat	Small	.01	.00	.01	.02
		.54	.08	.25	.87

Undiscounted Total Dollar Losses (1,000)

Vessel Type	Size	Collision	Ramming	Grounding	Total
Passenger	Small	68	9	54	131
Dry Cargo	Large	5	1	2	8
Dry Cargo	Medium	[illegible]	2	1	12
Dry Cargo	Small	251	27	44	322
Tanker	Large	111	27	101	240
Tanker	Medium	5	0	1	6
Tanker	Small	1	0	1	2
Dry Cargo Barge T	Small	0	0	0	0
Tanker Barge Tow	Large	70	33	35	139
Tanker Barge Tow	Small	86	15	11	113
Tug/Tow Boat	Small	1	0	0	1
		608	115	250	973

Note: In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 11 Avoided Fatalities 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Small	.01	.00	.01	.01
Dry Cargo	Large	.00	.00	.00	.00
Dry Cargo	Medium	.00	.00	.00	.00
Dry Cargo	Small	.02	.00	.00	.03
Tanker	Small	.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	.00	.00	.00	.00
Tanker Barge Tow	Small	.00	.00	.00	.00
Tug/Tow Boat	Small	.00	.00	.00	.00
Totals		.03	.00	.01	.05
Candidate VTS Design - Dollars					
Passenger	Small	7,502.54	1,176.33	8,444.70	17,123.57
Dry Cargo	Large	681.87	119.00	943.72	1,744.59
Dry Cargo	Medium	1,214.49	200.77	540.17	1,955.43
Dry Cargo	Small	35,559.75	4,209.33	6,913.21	46,682.28
Tanker	Small	7.53	0.00	6.57	14.11
Dry Cargo Barge Tow	Small	3.25	1.02	1.45	5.72
Tanker Barge Tow	Small	103.39	18.81	77.41	199.61
Tug/Tow Boat	Small	22.99	8.12	18.77	49.89
Totals		45,095.82	5,733.38	16,946.01	67,775.21

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 12 Avoided Human Injuries 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Small	.06	.01	.07	.14
Dry Cargo	Large	.00	.00	.00	.00
Dry Cargo	Medium	.00	.00	.00	.00
Dry Cargo	Small	.28	.03	.05	.37
Tanker	Small	.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	.00	.00	.00	.00
Tanker Barge Tow	Small	.00	.00	.00	.00
Tug/Tow Boat	Small	.00	.00	.00	.00
Totals		.34	.04	.12	.51
Candidate VTS Design - Dollars					
Passenger	Small	14,127.40	2,215.05	15,901.52	32,243.97
Dry Cargo	Large	11.71	2.04	16.20	29.95
Dry Cargo	Medium	20.85	3.45	9.27	33.57
Dry Cargo	Small	66,959.59	7,926.24	13,017.68	87,903.52
Tanker	Small	13.16	0.00	11.49	24.65
Dry Cargo Barge Tow	Small	5.68	1.79	2.53	10.00
Tanker Barge Tow	Small	180.66	32.86	135.27	348.79
Tug/Tow Boat	Small	40.18	14.19	32.80	87.17
Totals		81,359.24	10,195.62	29,126.76	120,681.62

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 13 Avoided Vessels Damaged 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Small	.07	.01	.03	.10
Dry Cargo	Large	.00	.00	.00	.00
Dry Cargo	Medium	.00	.00	.00	.01
Dry Cargo	Small	.32	.03	.04	.39
Tanker	Large	.02	.00	.01	.03
Tanker	Medium	.00	.00	.00	.00
Tanker	Small	.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	.00	.00	.00	.00
Tanker Barge Tow	Large	.01	.00	.00	.02
Tanker Barge Tow	Small	.02	.00	.00	.03
Tug/Tow Boat	Small	.00	.00	.00	.00
Totals		.45	.05	.08	.58
Candidate VTS Design - Dollars					
Passenger	Small	22,698.03	2,781.64	14,156.20	39,635.88
Dry Cargo	Large	1,981.90	331.01	290.62	2,603.53
Dry Cargo	Medium	4,264.60	674.66	124.37	5,063.63
Dry Cargo	Small	60,245.03	5,798.80	9,681.87	75,725.70
Tanker	Large	14,919.49	3,765.13	10,951.88	29,636.49
Tanker	Medium	1,668.89	170.76	538.09	2,377.74
Tanker	Small	149.30	0.00	169.94	319.23
Dry Cargo Barge Tow	Small	43.55	7.60	3.10	54.24
Tanker Barge Tow	Large	2,078.49	550.27	409.43	3,038.18
Tanker Barge Tow	Small	1,692.99	170.51	294.31	2,157.81
Tug/Tow Boat	Small	87.73	19.91	69.64	177.29
Totals		109,829.99	14,270.29	36,689.44	160,789.72

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 14 Avoided Cargo Damage/Loss 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Small	.02	.00	.01	.03
Dry Cargo	Large	.00	.00	.00	.00
Dry Cargo	Medium	.00	.00	.00	.00
Dry Cargo	Small	.12	.01	.01	.14
Tanker	Large	.01	.00	.00	.01
Tanker	Medium	.00	.00	.00	.00
Tanker	Small	.00	0.00	.00	.00
Dry Cargo Tow	Small	.00	.00	.00	.00
Tanker Tow	Large	.00	.00	.00	.00
Tanker Tow	Small	.00	.00	.00	.01
Tug/Tow Boat	Small	.00	.00	.00	.00
Totals		.15	.02	.03	.20
Candidate VTS Design - Dollars					
Passenger	Small	57.40	7.03	31.97	96.41
Dry Cargo	Large	10.20	2.52	1.34	14.06
Dry Cargo	Medium	18.17	4.26	.76	23.20
Dry Cargo	Small	273.41	26.32	43.46	343.19
Tanker	Large	424.15	102.54	538.97	1,065.67
Tanker	Medium	12.87	1.30	2.98	17.15
Tanker	Small	1.91	0.00	1.04	2.95
Tanker Tow	Large	334.00	160.98	233.77	728.74
Tanker Tow	Small	417.46	75.92	127.26	620.65
Tug/Tow Boat	Small	1.06	.24	.82	2.11
Totals		1,550.64	381.11	982.36	2,914.12

Note1: Dollar [illegible] include bulk petroleum and chemical cargos only and all vessel fuels spilled. Dollar values exclude cargo loss/damage for non-tank vessel types.

Note2: In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 15 Avoided NavAid Damage 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Small	0.00	.00	.00	.00
Dry Cargo	Large	0.00	.00	.00	.00
Dry Cargo	Medium	0.00	.00	.00	.00
Dry Cargo	Small	0.00	.01	.00	.01
Tanker	Large	0.00	.00	.00	.00
Tanker	Medium	0.00	.00	.00	.00
Tanker	Small	0.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	0.00	.00	.00	.00
Tanker Barge Tow	Large	0.00	.00	.00	.00
Tanker Barge Tow	Small	0.00	.00	.00	.00
Tug/Tow Boat	Small	0.00	.00	.00	.00
Totals		0.00	.01	.00	.01
Candidate VTS Design - Dollars					
Passenger	Small	0.00	7.91	2.84	10.75
Dry Cargo	Large	0.00	.41	.16	.57
Dry Cargo	Medium	0.00	.69	.09	.78
Dry Cargo	Small	0.00	28.30	2.33	30.63
Tanker	Large	0.00	3.87	1.25	5.12
Tanker	Medium	0.00	.21	.07	.28
Tanker	Small	0.00	0.00	.06	.06
Dry Cargo Barge Tow	Small	0.00	.20	.01	.21
Tanker Barge Tow	Large	0.00	4.36	.33	4.69
Tanker Barge Tow	Small	0.00	3.67	.76	4.43
Tug/Tow Boat	Small	0.00	1.59	.18	1.77
Totals		0.00	51.20	8.10	59.30

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 16 Avoided Bridge Damage 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Dry Cargo	Small	0.00	0.00	0.00	0.00
Totals		0.00	0.00	0.00	0.00
Candidate VTS Design - Dollars					
Dry Cargo	Small	0.00	0.00	0.00	0.00
Totals		0.00	0.00	0.00	0.00

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

Appendix Q   Zone 17 Portland, ME
TABLE 17 Avoided Hazardous Commodity Spills 1996 - 2010   7/30/91

Commodity	Catastrophic	Large	Medium	Small	Total
Candidate Vts Design - Counts					
JET FUEL	.00	.00	.00	.00	.00
KEROSENE	.00	.00	.00	.00	.00
RESIDUAL FUEL OIL	.00	.00	.00	.01	.01
DISTILLATE FUEL OIL	.00	.00	.00	.11	.11
GASOLINE, INCL NATURAL	.00	.00	.00	.00	.00
CRUDE PETROLEUM	.00	.00	.00	.00	.00
	.00	.00	.01	.11	.13

Note: In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

Appendix Q Zone 17 Portland, ME
TABLE 18A Annual Benefit & Cost Streams 7/31/91
Candidate VTS Systems

Discounted to 1993

Year	Investment ($1,000)	Operation & Maintenance ($1,000)	Benefits ($1,000)
1993	4,677	0	0
1996	0	360	43
1997	0	327	40
1998	0	297	37
1999	0	270	35
2000	0	246	30
2001	0	223	30
2002	0	203	28
2003	0	185	26
2004	0	168	25
2005	0	153	23
2006	0	139	22
2007	0	126	20
2008	0	115	19
2009	0	104	18
2010	0	95	14
	4,677	3,010	410

Undiscounted

Year	Investment ($1,000)	Operation & Maintenance ($1,000)	Benefits ($1,000)
1993	4,677	0	0
1996	0	457	54
1997	0	457	56
1998	0	457	57
1999	0	457	59
2000	0	457	56
2001	0	457	62
2002	0	457	64
2003	0	457	65
2004	0	457	67
2005	0	457	69
2006	0	457	71
2007	0	457	74
2008	0	457	76
2009	0	457	78
2010	0	457	66
	4,677	6,857	973

APPENDIX Q

ZONE 17 - PORTLAND, ME

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Portland, Maine		(Port 17)		Wildlife Abundance Tables Fish & Shellfish Grams per Square Meter			
Port & Subzone	Species Category	Species Code	Species Name	Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
1701	101	1	American Shad	.0045	.0045	.0045	.0021
1701	101	2	Alewife	.2200	.2200	.2200	.1000
1701	102	3	Menhaden	2.8000	4.2000	2.8000	0.0000
1701	102	4	Herring	.6300	.6300	.6300	.6300
1701	102	5	Butterfish	.0590	.0590	.0590	.0590
1701	102	6	Pollock	1.4000	1.4000	1.4000	1.4000
1701	102	7	Atlantic Mackerel	3.0000	3.0000	3.0000	3.0000
1701	102	32	King Mackerel	.0095	.0190	.0095	0.0000
1701	102	44	Striped Mullet	.0240	.0240	.0240	.0240
1701	103	8	Bluefish	.4100	.8400	.4100	0.0000
1701	103	9	Striped Bass	.0050	.0050	.0100	.0100
1701	103	10	Monkfish	.0810	.0810	.0810	.0810
1701	103	11	Weakfish	.0120	.1020	.0120	.0120
1701	104	12	Tuna	0.0000	.0930	0.0000	0.0000
1701	104	13	Swordfish	.0430	.0430	.0430	.0430
1701	104	14	Shark	.0042	.0042	.0042	.0042
1701	104	15	Dogfish	1.0300	1.0300	1.0300	1.0300
1701	106	21	Atlantic Cod	.5900	.5900	.5900	.5900
1701	106	22	Haddock	.1200	.1200	.1200	.1200
1701	106	23	Redfish	.1400	.1400	.1400	.1400
1701	106	24	Silver Hake	.7900	.7900	.7900	.7900
1701	106	25	Red Hake	.5900	.5900	.5900	.5900
1701	106	26	White Hake	.3200	.3200	.3200	.3200
1701	106	27	Scup	.2000	.2000	.2000	.2000
1701	106	28	Tilefish	.0160	.0160	.0160	.0160
1701	106	29	Black Sea Bass	.0170	.0170	.0170	.0170
1701	106	30	Atlantic Wolffish	.0140	.0140	.0140	.0140
1701	106	35	Atlantic Croaker	.0240	.0240	.0240	.0240
1701	106	66	Cusk	.2800	.2800	.2800	.2800
1701	106	67	Tautog	1.1000	1.1000	1.1000	1.1000
1701	106	199	Other Fish	.1100	.1100	.1100	.1100
1701	107	299	Other Invertebrates	.1100	.1100	.1100	.1100
1701	108	204	American Lobster	.4600	.4600	.4600	.4600
1701	108	205	Northern Shrimp	.0280	.0280	.0280	.0280
1701	108	206	Red Crab	.1200	.1200	.1200	.1200
1701	109	207	Squid	.3900	.3900	.3900	.3900
1702	101	1	American Shad	.0045	.0045	.0045	.0021
1702	101	2	Alewife	.2200	.2200	.2200	.1000
1702	102	3	Menhaden	2.8000	4.2000	2.8000	0.0000
1702	102	4	Herring	.6300	.6300	.6300	.6300
1702	102	5	Butterfish	.0590	.0590	.0590	.0590
1702	102	6	Pollock	1.4000	1.4000	1.4000	1.4000
1702	102	7	Atlantic Mackerel	3.0000	3.0000	3.0000	3.0000
1702	102	32	King Mackerel	.0095	.0190	.0095	0.0000
1702	102	44	Striped Mullet	.0240	.0240	.0240	.0240
1702	103	8	Bluefish	.4100	.8400	.4100	0.0000
1702	103	9	Striped Bass	.0050	.0050	.0100	.0100
1702	103	10	Monkfish	.0810	.0810	.0810	.0810
1702	103	11	Weakfish	.0120	.1020	.0120	.0120
1702	104	12	Tuna	0.0000	.0930	0.0000	0.0000
1702	104	13	Swordfish	.0430	.0430	.0430	.0430
1702	104	14	Shark	.0042	.0042	.0042	.0042
1702	104	15	Dogfish	1.0300	1.0300	1.0300	1.0300
1702	106	21	Atlantic Cod	.5900	.5900	.5900	.5900

ZONE 17 - PORTLAND, ME (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Portland, Maine Port & Subzone	Species Category	(Port 17) Species Code	Species Name	Wildlife Abundance Tables Fish & Shellfish Grams per Square Meter Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
1702	106	22	Haddock	.1200	.1200	.1200	.1200
1702	106	23	Redfish	.1400	.1400	.1400	.1400
1702	106	24	Silver Hake	.7900	.7900	.7900	.7900
1702	106	25	Red Hake	.5900	.5900	.5900	.5900
1702	106	26	White Hake	.3200	.3200	.3200	.3200
1702	106	27	Scup	.2000	.2000	.2000	.2000
1702	106	28	Tilefish	.0160	.0160	.0160	.0160
1702	106	29	Black Sea Bass	.0170	.0170	.0170	.0170
1702	106	30	Atlantic Wolffish	.0140	.0140	.0140	.0140
1702	106	35	Atlantic Croaker	.0240	.0240	.0240	.0240
1702	106	66	Cusk	.2800	.2800	.2800	.2800
1702	106	67	Tautog	1.1000	1.1000	1.1000	1.1000
1702	106	199	Other Fish	.1100	.1100	.1100	.1100
1702	107	299	Other Invertebrates	.1100	.1100	.1100	.1100
1702	108	204	American Lobster	.4600	.4600	.4600	.4600
1702	108	205	Northern Shrimp	.0280	.0280	.0280	.0280
1702	108	206	Red Crab	.1200	.1200	.1200	.1200
1702	109	207	Squid	.3900	.3900	.3900	.3900
1703	101	1	American Shad	.1200	.0580	0.0000	.0580
1703	101	2	Alewife	.4100	.4100	.4100	.4100
1703	101	31	Hickory Shad	.0120	.0060	0.0000	.0060
1703	102	3	Menhaden	22.1000	22.4000	11.2000	0.0000
1703	102	4	Herring	.0010	.0010	.0010	.0010
1703	102	7	Atlantic Mackerel	.0040	0.0000	0.0000	.0040
1703	102	32	King Mackerel	.0030	0.0000	0.0000	.0030
1703	102	33	Spanish Mackerel	.0210	0.0000	0.0000	.0210
1703	102	34	Harvestfish	.0010	.0010	.0010	.0010
1703	103	8	Bluefish	.2700	.3200	.3200	0.0000
1703	103	9	Striped Bass	.2600	.4700	.4200	.4200
1703	103	11	Weakfish	.3100	.3100	.3100	.0070
1703	105	17	Summer Flounder	.0280	.0280	.0280	.0280
1703	105	18	American Plaice	.0170	.0090	.0090	.0100
1703	105	20	Winter Flounder	.0530	.0020	.0700	.0880
1703	106	24	Silver Hake	.0010	.0010	.0010	.0010
1703	106	25	Red Hake	.0040	.0020	.0030	.0030
1703	106	26	White Hake	.0090	.0140	.0050	0.0000
1703	106	29	Black Sea Bass	.0010	.0010	.0010	.0010
1703	106	35	Atlantic Croaker	.3700	.3700	.3700	0.0000
1703	106	36	Drum	.0020	.0020	.0020	0.0000
1703	106	37	Spot	.0960	.0490	0.0000	.0490
1703	106	38	Yellow Perch	.0020	.0020	.0020	.0020
1703	106	39	Carp	.0250	.0250	.0250	.0250
1703	106	40	Eel	.1400	.1400	.1400	.1400
1703	106	199	Other Fish	.7800	.7800	.7800	.7800
1703	107	211	Soft Clam	.1700	.1700	.1700	.1700
1703	107	212	Atlantic Oyster	1.9000	1.9000	1.9000	1.9000
1703	107	213	Hard Clam	.0800	.0800	.0800	.0800
1703	107	214	Conch	.0660	.0660	.0660	.0660
1703	108	204	American Lobster	.1100	.2200	.1100	0.0000
1703	108	209	Hard Blue Crab	4.1000	4.1000	4.1000	4.1000
1703	108	210	Soft Blue Crab	.2000	.2000	0.0000	0.0000
1703	109	207	Atlantic Squid	.0280	.1500	.1300	0.0000
1704	101	1	American Shad	.0047	.0047	.0047	0.0000
1704	101	2	Alewife	.2200	.2200	.2200	0.0000

ZONE 17 - PORTLAND, ME (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Portland, Maine Port & Subzone	Species Category	(Port 17) Species Code	Species Name	Wildlife Abundance Tables Fish & Shellfish Grams per Square Meter Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
1704	102	3	Menhaden	0.0000	2.8000	0.0000	0.0000
1704	102	4	Herring	1.2500	1.2500	1.2500	1.2500
1704	102	5	Butterfish	.0610	.0610	.0610	.0610
1704	102	6	Pollock	2.7600	2.7600	2.7600	2.7600
1704	102	7	Atlantic Mackerel	3.1500	3.1500	3.1500	3.1500
1704	103	8	Bluefish	0.0000	.2700	0.0000	0.0000
1704	103	9	Striped Bass	.0050	.0050	.0100	.0100
1704	103	10	Monkfish	.0840	.0840	.0840	.0840
1704	104	12	Tuna	0.0000	.1600	0.0000	0.0000
1704	104	13	Swordfish	.0530	.0530	.0530	.0530
1704	104	14	Shark	.0043	.0043	.0043	.0043
1704	104	15	Dogfish	1.0700	1.0700	1.0700	1.0700
1704	105	16	Yellowtail	.2700	.2700	.2700	.2700
1704	105	17	Summer Flounder	.0930	.0930	.0930	.0930
1704	105	18	American Plaice	.4300	.4300	.4300	.4300
1704	105	19	Witch Flounder	.1300	.1300	.1300	.1300
1704	105	20	Winter Flounder	.1200	.1200	.1200	.1200
1704	105	49	Atlantic Halibut	.0017	.0017	.0017	.0017
1704	106	21	Atlantic Cod	1.1800	1.1800	1.1800	1.1800
1704	106	22	Haddock	.2400	.2400	.2400	.2400
1704	106	25	Red Hake	.5200	.5200	.5200	.5200
1704	106	26	White Hake	.6400	.6400	.6400	.6400
1704	106	27	Scup	.2000	.2000	.2000	.2000
1704	106	29	Black Sea Bass	.0037	.0037	.0037	.0037
1704	106	30	Atlantic Wolffish	.0280	.0280	.0280	.0280
1704	106	199	Other Fish	.0750	.0750	.0750	.0750
1704	107	202	Ocean Quahog	3.4000	3.4000	3.4000	3.4000
1704	107	203	Atlantic Sea Scallop	.1100	.1100	.1100	.1100
1704	107	299	Other Invertebrates	.1800	.1800	.1800	.1800
1704	108	204	American Lobster	.3300	.3300	.3300	.3300
1704	108	205	Northern Shrimp	.0560	.0560	.0560	.0560
1704	109	207	Blue Crab	.1700	.1700	.1700	.1700

APPENDIX Q

ZONE 17 - PORTLAND, ME (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Portland, Maine		(Port 17)		Wildlife Abundance Tables Fish & Shellfish Larvae Numbers per Square Meter			
Port & Subzone	Species Category	Species Code	Species Name	Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
1701	202	1004	Atlantic Herring	.3000	0.0000	50.0000	3.0000
1701	202	1005	Butterfish	0.0000	.5000	0.0000	0.0000
1701	202	1006	Pollock	.5000	0.0000	5.0000	5.0000
1701	202	1007	Atlantic Mackerel	10.0000	5.0000	0.0000	0.0000
1701	202	1110	Sand Lance	.5000	0.0000	0.0000	0.0000
1701	203	1199	Larvae	.0110	.1700	.0054	0.0000
1701	205	1016	Yellowtail Flounder	.5000	5.0000	0.0000	0.0000
1701	205	1018	American Plaice	5.0000	0.0000	0.0000	0.0000
1701	205	1019	Witch Flounder	5.0000	0.0000	0.0000	0.0000
1701	206	1021	Atlantic Cod	.5000	0.0000	.0500	0.0000
1701	206	1023	Redfishes	0.0000	5.0000	0.0000	0.0000
1701	206	1024	Silver Hake	0.0000	5.0000	.5000	0.0000
1701	206	1026	Hake	0.0000	.5000	.0500	0.0000
1701	206	1255	Cunner	0.0000	50.0000	5.0000	0.0000
1701	207	1199	Larvae	2.0000	20.0000	2.0000	0.0000
1701	208	1199	Larvae	.0016	.0042	0.0000	0.0000
1702	202	1004	Atlantic Herring	.3000	0.0000	50.0000	3.0000
1702	202	1005	Butterfish	0.0000	.5000	0.0000	0.0000
1702	202	1006	Pollock	.5000	0.0000	5.0000	5.0000
1702	202	1007	Atlantic Mackerel	10.0000	5.0000	0.0000	0.0000
1702	202	1110	Sand Lance	.5000	0.0000	0.0000	0.0000
1702	203	1199	Larvae	.0110	.1700	.0054	0.0000
1702	205	1016	Yellowtail Flounder	.5000	5.0000	0.0000	0.0000
1702	205	1018	American Plaice	5.0000	0.0000	0.0000	0.0000
1702	205	1019	Witch Flounder	5.0000	0.0000	0.0000	0.0000
1702	206	1021	Atlantic Cod	.5000	0.0000	.0500	0.0000
1702	206	1023	Redfishes	0.0000	5.0000	0.0000	0.0000
1702	206	1024	Silver Hake	0.0000	5.0000	.5000	0.0000
1702	206	1026	Hake	0.0000	.5000	.0500	0.0000
1702	206	1255	Cunner	0.0000	50.0000	5.0000	0.0000
1702	207	1199	Larvae	2.0000	20.0000	2.0000	0.0000
1702	208	1199	Larvae	.0016	.0042	0.0000	0.0000
1703	202	1004	Herring	.3207	.3207	.3207	.2328
1703	202	1010	Sand Lance	1.1120	.3706	0.0000	.7119
1703	202	1060	Pollock	.0819	0.0000	0.0000	.1003
1703	202	1121	Blenny	.1001	0.0000	0.0000	.4095
1703	202	1127	Silverside	.0067	.0067	0.0000	0.0000
1703	202	1248	Wrymouth	.0552	0.0000	0.0000	.1401
1703	203	1199	Larvae	.0640	1.1000	.0310	0.0000
1703	205	1020	Winter Flounder	.3082	.3082	0.0000	0.0000
1703	205	1251	Smooth Flounder	.0485	0.0000	0.0000	.0510
1703	206	1040	American Eel	.0145	0.0000	0.0000	0.0000
1703	206	1103	Smelt	.9618	.9618	0.0000	0.0000
1703	206	1109	Sculpin	.0068	.0068	.0068	0.0000
1703	206	1109	Sculpin	.7752	0.0000	0.0000	1.2073
1703	206	1112	Sea Snail	1.0191	0.0000	0.0000	.0760
1703	206	1114	Gunnel	2.4939	0.0000	3.2570	3.2570
1703	206	1199	Alligator Fish	.0338	0.0000	.0338	0.0000
1703	206	1199	Radiated Shanny	.4172	.4172	.4172	0.0000
1703	206	1244	Pipefish	.0060	.0060	0.0000	0.0000
1703	206	1259	Atlantic Tomcod	.0034	0.0000	.0034	.0364
1703	207	1199	Larvae	100.0000	1000.0000	100.0000	0.0000
1703	208	1199	Larvae	.0160	.0420	0.0000	0.0000
1704	202	1004	Atlantic Herring	.3000	0.0000	50.0000	3.0000

ZONE 17 - PORTLAND, ME (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Portland, Maine		(Port 17)		Wildlife Abundance Tables Fish & Shellfish Larvae Numbers per Square Meter			
Port & Subzone	Species Category	Species Code	Species Name	Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
1704	202	1005	Butterfish	0.0000	.5000	0.0000	0.0000
1704	202	1006	Pollock	.5000	0.0000	5.0000	5.0000
1704	202	1007	Atlantic Mackerel	10.0000	5.0000	0.0000	0.0000
1704	202	1110	Sand Lance	.5000	0.0000	0.0000	0.0000
1704	203	1199	Larvae	.0110	.1700	.0054	0.0000
1704	205	1016	Yellowtail Flounder	.5000	5.0000	0.0000	0.0000
1704	205	1018	American Plaice	5.0000	0.0000	0.0000	0.0000
1704	205	1019	Witch Flounder	5.0000	0.0000	0.0000	0.0000
1704	206	1021	Atlantic Cod	.5000	0.0000	.0500	0.0000
1704	206	1023	Redfishes	0.0000	5.0000	0.0000	0.0000
1704	206	1024	Silver Hake	0.0000	5.0000	.5000	0.0000
1704	206	1026	Hake	0.0000	.5000	.0500	0.0000
1704	206	1255	Cunner	0.0000	50.0000	5.0000	0.0000
1704	207	1199	Larvae	2.0000	20.0000	2.0000	0.0000
1704	208	1199	Larvae	.0016	.0042	0.0000	0.0000

APPENDIX Q

ZONE 17 - PORTLAND, ME (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Portland, Maine		(Port 17)		Wildlife Abundance Tables Birds Numbers per Square Kilometer			
Port & Subzone	Species Category	Species Code	Species Name	Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
1701	111	511	Duck	150.0000	0.0000	150.0000	300.0000
1701	111	513	Geese	75.0000	0.0000	75.0000	150.0000
1701	111	514	Swan	.5900	.5900	.5900	.5900
1701	111	517	Common Loon	.0200	0.0000	.0500	.0100
1701	111	517	Red-throated Loon	0.0000	0.0000	.0100	.0100
1701	112	530	Shorebird	49.2000	297.9000	108.5000	6.9000
1701	113	530	Cormorant	.0900	0.0000	.0200	0.0000
1701	113	531	Gull	5.3000	3.7500	13.6900	10.1600
1701	113	532	Black Legged Kittiwake	1.7500	.0100	.5000	9.3100
1701	113	533	Least Tern	.0100	.0900	.0900	0.0000
1701	113	533	Tern	0.0000	.0100	0.0000	0.0000
1701	113	534	Cory's Shearwater	0.0000	.0700	1.4200	0.0000
1701	113	534	Greater Shearwater	.0200	2.8800	11.4700	.0100
1701	113	534	Manx Shearwater	0.0000	.0100	0.0000	0.0000
1701	113	534	Scoty Shearwater	.0800	.4100	.0100	0.0000
1701	113	535	Other Jaeger	0.0000	.0100	.0200	0.0000
1701	113	535	Parasitic Jaeger	0.0000	0.0000	.0100	0.0000
1701	113	535	Pomarine Jaeger	0.0000	.0100	.1400	0.0000
1701	113	535	Skua	0.0000	0.0000	.0100	0.0000
1701	113	536	Northern Fulmar	4.4600	.3700	.8400	8.7300
1701	113	537	Leach's Storm Petrel	.0100	.2500	0.0000	0.0000
1701	113	537	Wilson's Storm Petrel	.1600	12.0300	.0900	0.0000
1701	113	538	Dovekie	.1900	0.0000	0.0000	.0500
1701	113	538	Large Alcid	.0900	0.0000	0.0000	.0800
1701	113	538	Murre	.1900	0.0000	0.0000	.0100
1701	113	538	Razorbill	.0200	0.0000	.0100	.0500
1701	113	539	Black Guillemot	0.0000	0.0000	0.0000	.0100
1701	113	540	Atlantic Puffin	0.0000	.0100	0.0000	.0200
1701	113	542	Other Phalarope	.0100	.0300	.0100	.1000
1701	113	542	Red Phalarope	.1000	.0500	.0200	.0100
1701	113	542	Red-necked Phalarope	0.0000	.0800	.1200	.0600
1701	113	547	Northern Gannet	.1900	.0100	.5400	.3400
1701	113	570	Seabird	19.1000	25.9000	27.6000	28.3000
1701	113	570	Seabird	19.1000	25.9000	27.6000	28.3000
1702	111	511	Duck	150.0000	0.0000	150.0000	300.0000
1702	111	513	Geese	75.0000	0.0000	75.0000	150.0000
1702	111	514	Swan	.5900	.5900	.5900	.5900
1702	111	517	Common Loon	.0200	0.0000	.0500	.0100
1702	111	517	Red-throated Loon	0.0000	0.0000	.0100	.0100
1702	112	530	Shorebird	49.2000	297.9000	108.5000	6.9000
1702	113	530	Cormorant	.0900	0.0000	.0200	0.0000
1702	113	531	Gull	5.3000	3.7500	13.6900	10.1600
1702	113	532	Black Legged Kittiwake	1.7500	.0100	.5000	9.3100
1702	113	533	Least Tern	.0100	.0900	.0900	0.0000
1702	113	533	Tern	0.0000	.0100	0.0000	0.0000
1702	113	534	Cory's Shearwater	0.0000	.0700	1.4200	0.0000
1702	113	534	Greater Shearwater	.0200	2.8800	11.4700	.0100
1702	113	534	Manx Shearwater	0.0000	.0100	0.0000	0.0000
1702	113	534	Scoty Shearwater	.0800	.4100	.0100	0.0000
1702	113	535	Other Jaeger	0.0000	.0100	.0200	0.0000
1702	113	535	Parasitic Jaeger	0.0000	0.0000	.0100	0.0000
1702	113	535	Pomarine Jaeger	0.0000	.0100	.1400	0.0000
1702	113	535	Skua	0.0000	0.0000	.0100	0.0000
1702	113	536	Northern Fulmar	4.4600	.3700	.8400	8.7300
1702	113	537	Leach's Storm Petrel	.0100	.2500	0.0000	0.0000

APPENDIX Q

ZONE 17 - PORTLAND, ME (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Portland, Maine		(Port 17)		Wildlife Abundance Tables Birds Numbers per Square Kilometer			
Port & Subzone	Species Category	Species Code	Species Name	Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
1702	113	537	Wilson's Storm Petrel	.1600	12.0300	.0900	0.0000
1702	113	538	Dovekie	.1900	0.0000	0.0000	.0500
1702	113	538	Large Alcid	.0900	0.0000	0.0000	.0800
1702	113	538	Murre	.1900	0.0000	0.0000	.0100
1702	113	538	Razorbill	.0200	0.0000	.0100	.0500
1702	113	539	Black Guillemot	0.0000	0.0000	0.0000	.0100
1702	113	540	Atlantic Puffin	0.0000	.0100	0.0000	.0200
1702	113	542	Other Phalarope	.0100	.0300	.0100	.1000
1702	113	542	Red Phalarope	.1000	.0500	.0200	.0100
1702	113	542	Red-necked Phalarope	0.0000	.0800	.1200	.0600
1702	113	547	Northern Gannet	.1900	.0100	.5400	.3400
1702	113	570	Seabird	19.1000	25.9000	27.6000	28.3000
1703	111	511	Duck	150.0000	0.0000	150.0000	300.0000
1703	111	513	Geese	75.0000	0.0000	75.0000	150.0000
1703	111	514	Swan	.5900	.5900	.5900	.5900
1703	112	530	Shorebird	49.2000	297.9000	108.5000	6.9000
1703	112	571	Blackbelted Plover	41.6700	250.0000	83.0000	6.0000
1703	112	571	Semipalmated Plover	30.0000	175.0000	60.0000	4.0000
1703	112	571	Short-billed Dowitcher	12.5000	75.0000	25.0000	2.0000
1703	112	571	Yellow-legged Sandpiper	12.5000	75.0000	25.0000	2.0000
1704	111	511	Duck	150.0000	0.0000	150.0000	300.0000
1704	111	513	Geese	75.0000	0.0000	75.0000	150.0000
1704	111	514	Swan	.5900	.5900	.5900	.5900
1704	111	517	Common Loon	.0200	0.0000	.0500	.0100
1704	111	517	Red-throated Loon	0.0000	0.0000	.0100	.0100
1704	112	530	Shorebird	49.2000	297.9000	108.5000	6.9000
1704	113	530	Cormorant	.0900	0.0000	.0200	0.0000
1704	113	531	Gull	5.3000	3.7500	13.6900	10.1600
1704	113	532	Black Legged Kittiwake	1.7500	.0100	.5000	9.3100
1704	113	533	Least Tern	.0100	.0900	.0900	0.0000
1704	113	533	Tern	0.0000	.0100	0.0000	0.0000
1704	113	534	Cory's Shearwater	0.0000	.0700	1.4200	0.0000
1704	113	534	Greater Shearwater	.0200	2.8800	11.4700	.0100
1704	113	534	Manx Shearwater	0.0000	.0100	0.0000	0.0000
1704	113	534	Scoty Shearwater	.0800	.4100	.0100	0.0000
1704	113	535	Other Jaeger	0.0000	.0100	.0200	0.0000
1704	113	535	Parasitic Jaeger	0.0000	0.0000	.0100	0.0000
1704	113	535	Pomarine Jaeger	0.0000	.0100	.1400	0.0000
1704	113	535	Skua	0.0000	0.0000	.0100	0.0000
1704	113	536	Northern Fulmar	4.4600	.3700	.8400	8.7300
1704	113	537	Leach's Storm Petrel	.0100	.2500	0.0000	0.0000
1704	113	537	Wilson's Storm Petrel	.1600	12.0300	.0900	0.0000
1704	113	538	Dovekie	.1900	0.0000	0.0000	.0500
1704	113	538	Large Alcid	.0900	0.0000	0.0000	.0800
1704	113	538	Murre	.1900	0.0000	0.0000	.0100
1704	113	538	Razorbill	.0200	0.0000	.0100	.0500
1704	113	539	Black Guillemot	0.0000	0.0000	0.0000	.0100
1704	113	540	Atlantic Puffin	0.0000	.0100	0.0000	.0200
1704	113	542	Other Phalarope	.0100	.0300	.0100	.1000
1704	113	542	Red Phalarope	.1000	.0500	.0200	.0100
1704	113	542	Red-necked Phalarope	0.0000	.0800	.1200	.0600
1704	113	547	Northern Gannet	.1900	.0100	.5400	.3400
1704	113	570	Seabird	19.1000	25.9000	27.6000	28.3000

APPENDIX R

PORTSMOUTH, NH

(ZONE 18)

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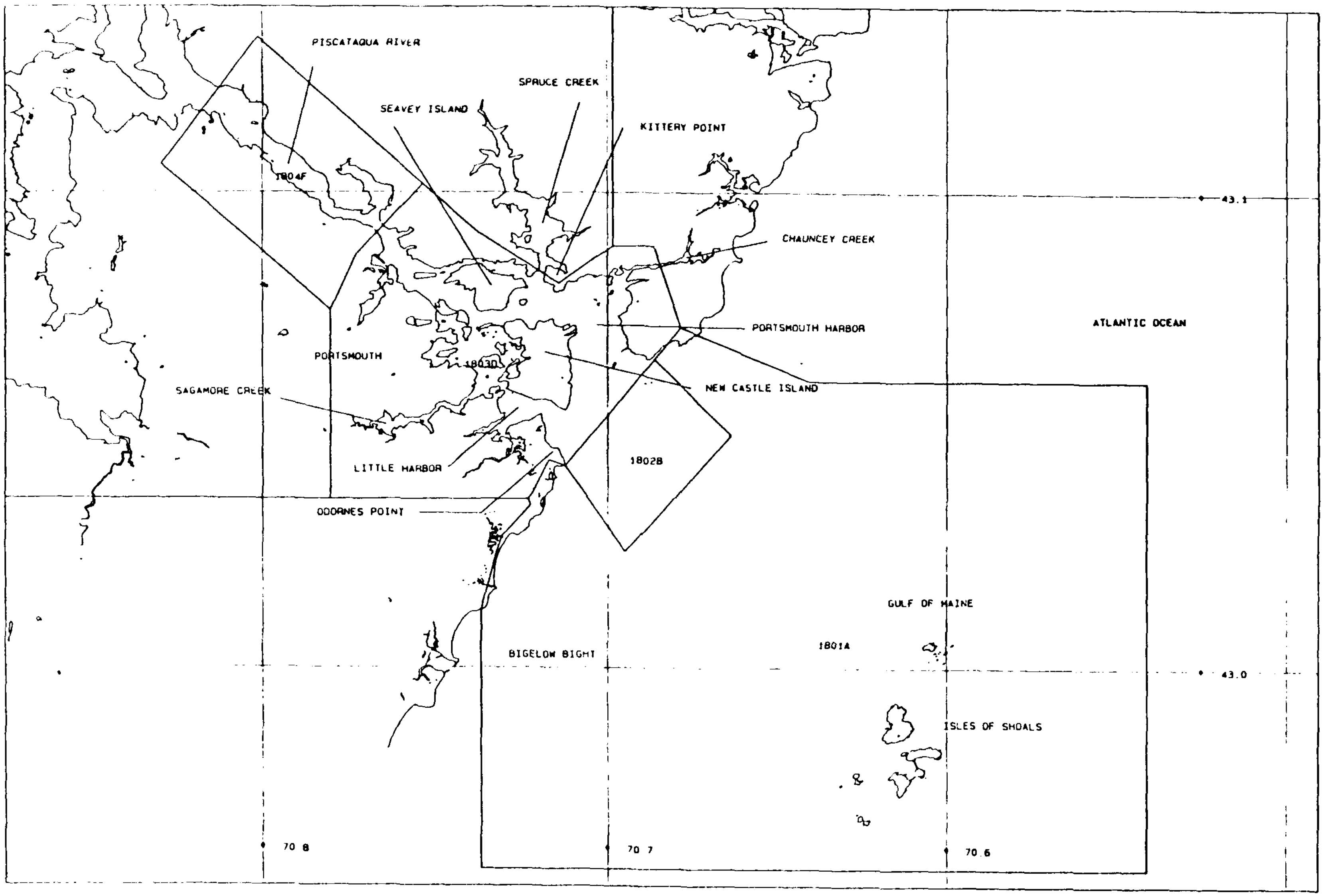
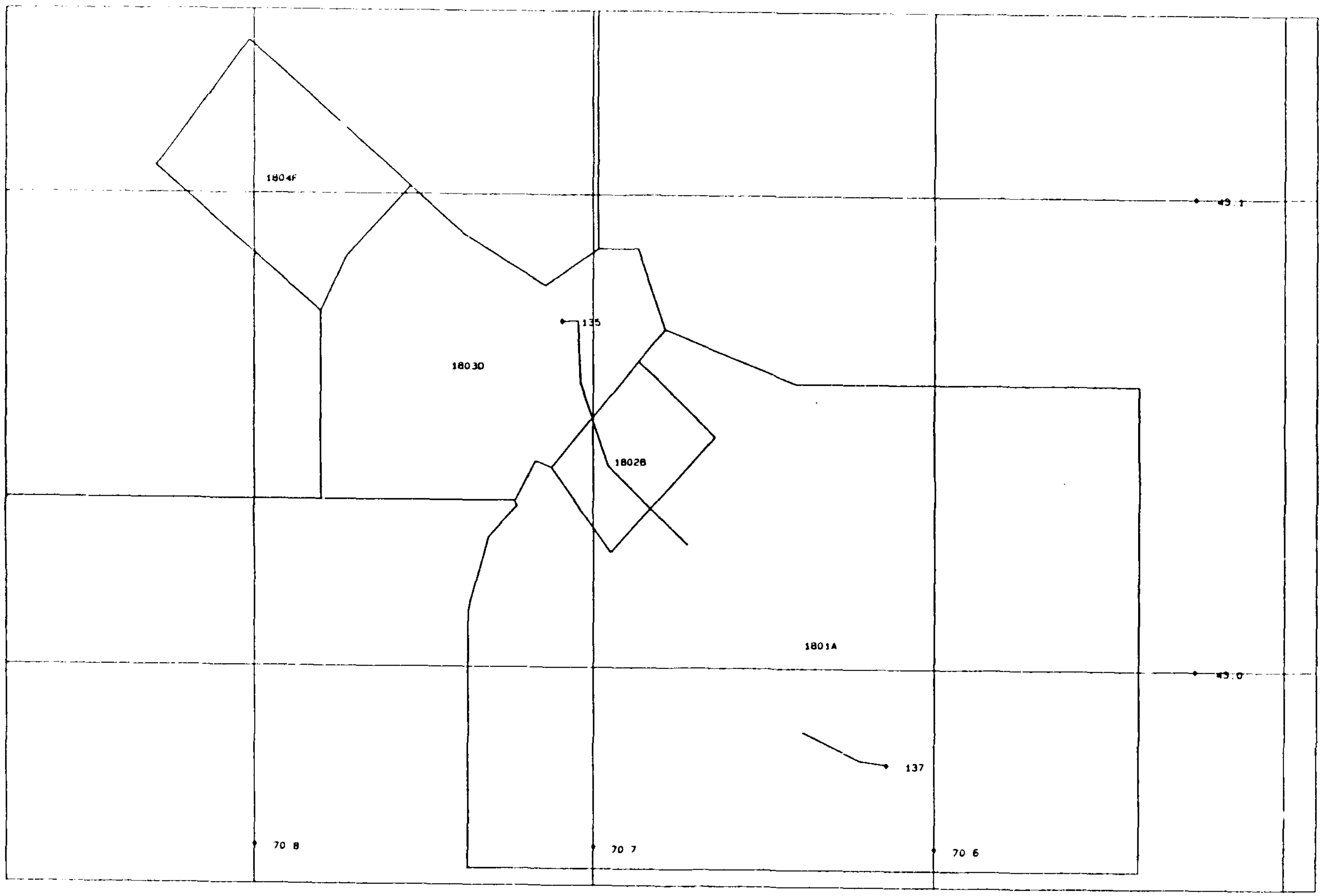
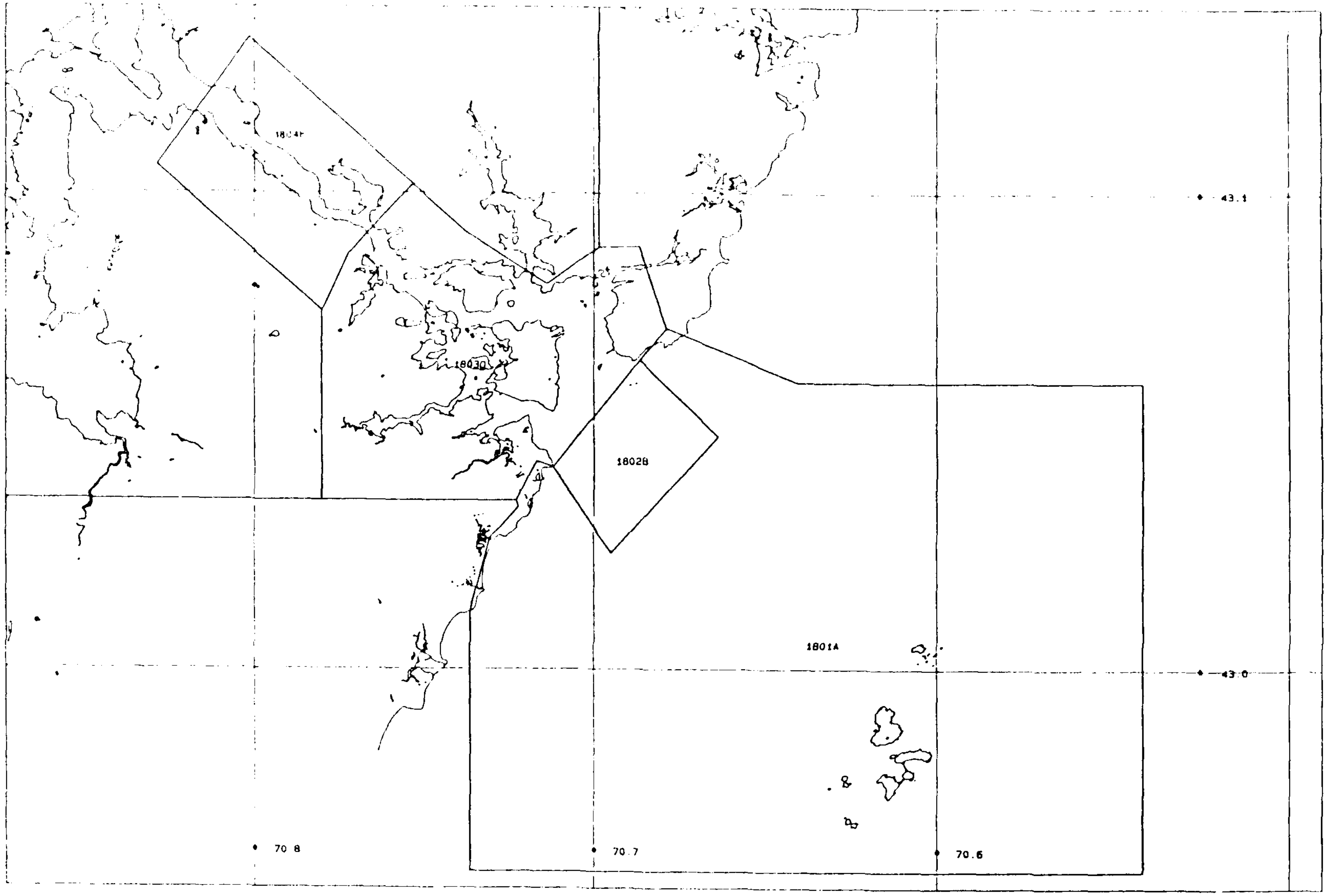
STUDY ZONE MAPS



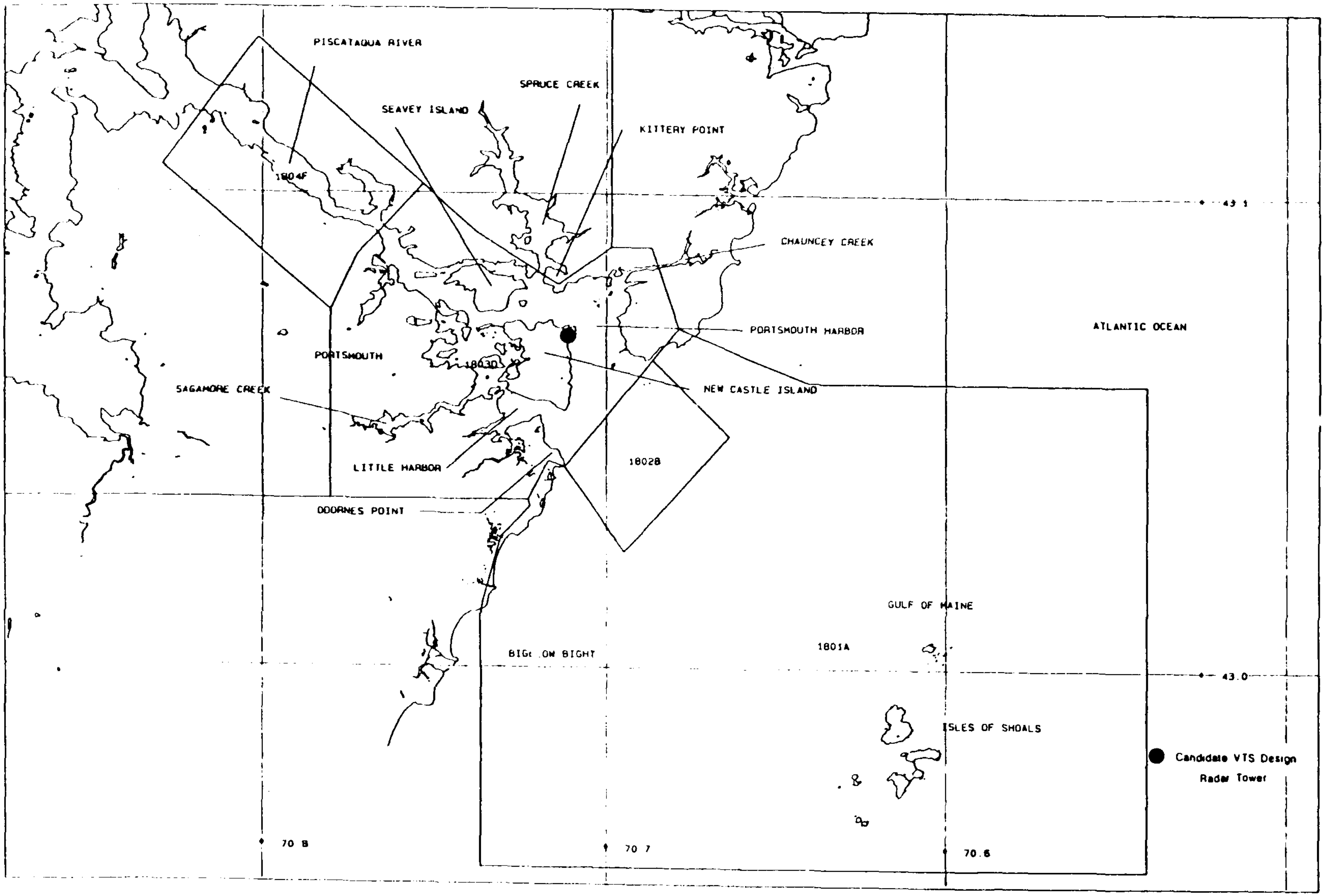
ZONE 18 - PORTSMOUTH, NH - ZONE AND SUBZONE BOUNDARIES



ZONE 18 - PORTSMOUTH, NH - DOMINANT VESSEL ROUTES AND COE WATERWAY CODES



ZONE 18 - PORTSMOUTH, NH - BASE PERIOD (10 YEAR) VESSEL CASUALTIES



ZONE 18 - PORTSMOUTH, NH - CANDIDATE VTS DESIGN RADAR LOCATIONS

CANDIDATE VTS DESIGN REPORT

FOR

PORTSMOUTH, NH

(ZONE 18)

Prepared for:
U.S. Department of Transportation
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Manassas, VA 22110

July 1991

OVERVIEW

The Candidate VTS Design described in this appendix is one of 23 developed for all the study zones included in the study. This appendix documents the task performed, under Contract DTRS-57-88-C-00088 Technical Task Directive 13, as an integral part of the total Port Needs Study. The ultimate product of this task effort is an informed preliminary technical assessment of the approximate cost to the Federal Government to implement and operate a state-of-the-art VTS system. This appendix does not contain a comprehensive definition of the VTS operating requirements nor does it propose a final VTS specification suitable for implementation.

In order to consistently estimate the life cycle costs of a VTS system in each of the study zones, a "Candidate VTS Design" has been defined for each study zone using a uniform set of design criteria. Each study zone Candidate VTS Design is a composite of generic modules selected from a master list of 18 state-of-the-art surveillance modules, communications and display technology. Among the surveillance modules in the master list are several levels of technical performance from which the selection is made for application to each study sub-zone to address the local navigational surveillance needs and conditions. The Candidate VTS Design in each study zone represents a consistent application of the surveillance modules at the sub-zone level. The sub-zone surveillance technology is subsequently integrated into a total system for the study zone via state-of-the-art communications and display consoles at the Vessel Traffic Center (VTC) in each zone.

The application of the surveillance modules in each sub-zone responds to the technical requirements of that sub-zone as perceived by the study team. The Candidate VTS Design represents a preliminary engineering judgement on the appropriate level of technology in each sub-zone. The Candidate VTS Design may be considered as an informed judgement made by the contractor study team for the sole purpose of developing cost estimates that are consistent across the 23 study zones and suitable for benefit/cost comparisons among the study zones and initial budget planning and implementation priorities. The approach used to calculate VTS system costs for all 23 study zones is found in Volume III, Technical Supplement.

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PORTSMOUTH, NEW HAMPSHIRE VTS DESIGN

1.0 SCOPE

This report includes a port survey and a VTS design for Portsmouth, New Hampshire. The port survey is based on a review of all pertinent literature including navigational charts. The methodology used to produce the VTS design entails coupling the problems identified in the port survey with solutions offered by state-of-the-art technology as identified in the VTS Technology Survey, November 1990. When possible, technological advances which permit manpower reductions are applied. Not all VTS problems are amenable to strictly technological solutions; some require changes in procedures and/or enforcement. These situations are identified where they occur.

2.0 PORT OF PORTSMOUTH SURVEY

2.1 INTRODUCTION

This survey report is based exclusively upon review of available literature and examination of the charts for the area and its approaches. The information thus gained has been evaluated and interpreted based upon the Survey Team's experience as professional mariners and in vessel traffic management systems.

The Survey Area includes the Port of Portsmouth, New Hampshire and its seaward approaches, as well as the Piscataqua River to the head of deep-draft navigation.

Portsmouth is a minor port, measured in terms of commercial and naval traffic. Based on 1990 traffic statistics, it experiences an average of only 1.4 vessel moves every 24 hours. Such averaging is misleading because movements are not distributed evenly throughout the day, or the month. Portsmouth is host to a nuclear-capable U. S. Navy shipyard and so is of strategic importance to the United States.

Tidal currents within the waterway serving the port are strong and at least one deep-draft facility lies upstream of a channel-constricting bridge. These conditions limit the movement of deep-draft ships to periods of minimum current.

The port area is environmentally sensitive, both because of the wildlife supported and the importance of recreation to the economy. The upper reaches of the Piscataqua River form an important habitat for aquatic birds and fish.

2.2 OVERVIEW OF THE PORT

Climate within the Survey Area is typically northern New England, marked by pleasant summers and falls, severe winters and dis

agreeable springs. The area experiences over 30 days per year when visibility is less than 0.5 mile for a portion of the day.

The diurnal tidal range is 8.7 feet at Kittery Point. Tidal currents are strong, particularly in that section of the Piscataqua River in the vicinity of the lift bridges. At maximum ebb unlighted buoys may be towed under by the current. In addition to primary currents, a number of strong eddies exist.

Once inside the Isles of Shoals, the approach to Portsmouth Harbor is generally free of dangers. Depths of about 35 feet can be carried in the marked Portsmouth Channel to the U. S. Route 1 (Memorial) Bridge. A Federal project provides a 30-foot channel from the bridge to a turning basin just above Johnson Island. The entrance and harbor channels are well marked by fixed aids to navigation, ranges and buoys. Loran-C coverage in the approaches is good.

Pilotage is compulsory for all foreign-flag ships and U. S.-flag ships under register in the foreign trade, and optional for U. S. flag ships in the coastwise trade who have a federally licensed pilot on board. The pilot service available is licensed for Portsmouth Harbor and the Piscataqua River and is also in command of the harbor tugs (which serve as pilot boats). Pilots monitor VHF-FM Channels 13 and 16, and use CH7A and CH77 as working frequencies. Pilots board and depart ships about 1 mile SSE of Kitts Rocks Lighted Whistle Buoy 2KR.

Ships should not proceed beyond Kitts Rock without a pilot or north of Wood Island even with a pilot in poor visibility.

The harbor provides a series of facilities, the details of which are set forth in the U. S. Army Corps of Engineers Port Series Reports, which should be consulted for details.

2.3 EXISTING TRAFFIC MANAGEMENT

2.3.1 Security Broadcast System, Portsmouth Harbor

The U. S. Coast Guard Captain of the Port (COTP) has established a voluntary system of radiotelephone broadcast and reporting procedures designed to give masters and pilots real-time information about vessel movements in and near Portsmouth Harbor. All vessels subject to the Bridge-to-Bridge Radiotelephone Regulations are urged to participate.

All participating vessels are asked to establish a listening guard on VHF-FM Channel 13 30 minutes prior to getting underway within the port or, if entering from sea, 30 minutes before arrival in the vicinity of Gunboat Shoal Lighted Bell Buoy 1. Security calls are to be made as follows:

Inbound traffic:

When passing Gunboat Shoal Lighted Bell Buoy 1 or Wood Island Lighted Bell Buoy 2, including announcement of destination.

When mooring or anchoring.

Outbound traffic:

Fifteen minutes prior to getting underway.

When getting underway, including announcement of route.

When passing Gunboat Shoal Lighted Bell Buoy 1 or Wood Island Lighted Bell Buoy 2.

The U. S. Coast Guard Station at Portsmouth Harbor monitors Channel 13. See the Coast Pilot (Reference 1) for additional details.

2.3.2 Established Practice

Pilots will not move deep-draft ships in poor visibility and restrict movement of deep-draft ships above the U. S. Route 1 Bridge to the three hour period centered on slack water (Reference 2).

Deep-draft ships moving to berths above the lift bridges normally require two or more tugs because of the strong river currents.

2.3.3 Regulated Navigation Area

A Regulated Navigation Area has been established in the vicinity of Portsmouth Naval Shipyard on Seavey Island by 33CFR165.101. No vessel may operate within this area at a speed in excess of five miles per hour.

2.3.4 Restricted Areas

Restricted Areas have been established in the vicinity of Portsmouth Naval Shipyard by 33CFR334.50. Vessels and persons may enter the Restricted Areas only with permission of the Commander, Portsmouth Naval Shipyard.

2.4 VESSEL TRAFFIC

An average of 60 movements occur each month, counting ships and tugs/barges. 1990 statistics, for the period 1 January through 31 August, showed movements by 20 barges, by 126 other vessels of all descriptions and 38 USN moves. Some of the ships included in the count were LPG carriers, but the exact number is not known.

2.5 ENVIRONMENTAL SENSITIVITY

The entire area must be considered sensitive to pollution because of the population density, the importance of tourism and recreational activities to the local economy and the small but important local fisheries. In addition, the wetlands bordering the Piscataqua River are important wildlife habitats and support migrating aquatic fowl using the Atlantic Flyway.

The "Worse Case" incident would probably be a major petroleum spill resulting from an accident which closed the U. S. Route 1 Bridge to both vehicle and ship traffic. Containment would be difficult to impossible because of current velocities and pollutants would extend to the coastal beaches on the ebb and to the Piscataqua wetlands during flood.

2.6 PORT SUB-ZONES

The Study Area was examined to determine appropriate sub-zones, using the methodology based upon the "confined-complex", "open-complex", "confined-simple" and "open-simple" system employed by the Canadian VTS Study in 1984 (Reference 3). Briefly stated, "open" and "confined" address the influence of geography upon a ship's ability to maneuver; and "simple" vs "complex" is descriptive of the nature of the interactions between ships within those geographic areas. This basic matrix was overlaid by a subjective assessment of appropriate traffic management/risk amelioration measures in order to derive sub-zones within which VTS needs are homogeneous, or nearly so.

2.6.1 Sub-Zone I -- Seaward Approaches (NOAA Chart 13278)

The sub-zone lies seaward of a line drawn east from the shoreline at 42^0-53N to 70^0-30'W, thence north to 43^0-10'N and west to the shoreline.

The sub-zone functions essentially as a data catchment area for shipping entering Portsmouth from the sea. The principal function of the VTS within the sub-zone is to establish communications with inbound traffic and obtain information about characteristics, intentions and movements.

The sub-zone is "open-simple."

2.6.2 Sub-Zone II -- Portsmouth Entrance (NOAA Charts 13278 & 13283)

This sub-zone lies inshore of Sub Zone I (a line drawn east from the shoreline at 42^0-53N to 70^0-30'W, thence north to 43^0-10'N and west to the shoreline) and a line drawn between Odiornes Point and West Sister.

Sub-Zone traffic is light but queuing may occasionally be required, particularly for shipping bound to and from the area above Seavey Island. The hard bottom provides little forgiveness for navigational errors and strong tidal currents are present. The VTC should be prepared to provide movement management advice, and navigational assistance to vessels in Bigelow Bight if required.

The sub-zone is "confined-complex."

2.6.3 Sub-Zone III -- Portsmouth (NOAA Charts 13283 & 13285)

The sub-zone lies between the inshore boundary of Sub-Zone II (a line drawn between Odiornes Point and West Sister) and the Upper Piscataqua River Turning Basin.

Sub-Zone traffic is light but management may be required when USN ships are maneuvering to make or leave berths at the shipyard, to prevent mutual interference under strong tidal current conditions and to preclude hazardous meetings. Queuing may occasionally be required.

The sub-zone is "confined-simple."

2.7 PROBLEM AREA IDENTIFIERS

2.7.1 PAI II-1. Bigelow Bight (NOAA Chart 13278)

Bigelow Bight offers several navigational hazards, particularly as Portsmouth is approached from the northward. The VTS should be capable of providing navigational assistance, if required.

2.7.2 PAI II-2. Isles of Shoals (NOAA Chart 13278)

Isles of Shoals offers a navigational challenge, particularly to inbound ships, during periods of poor visibility. In addition, the absence of adequate lay-anchorages within Portsmouth Harbor requires that ships delayed in entering must lie to or anchor between Isles of Shoals and Gunboat Shoal while awaiting passage. The VTS should be capable of providing movement management advice and navigational assistance.

2.7.3 PAI III-1. Portsmouth Harbor (NOAA Chart 13283)

Portsmouth Harbor, between Kittery Point and New Castle, is an undesignated anchorage used occasionally by ships awaiting berthing. The anchorage area occurs adjacent to a point where a 90^0 course change must be made, and represents the last point before inbound ships are committed to transit to berth. Movement management assistance may be required, especially when protracted evolutions are occurring at the USN facilities at Seavey Island. Navigational assistance is not feasible because of the narrowness of the waterway.

2.7.4 PAI III-2. Piscataqua River (NOAA Charts 13283 & 13285)

A combination of strong tidal currents, narrow bridge spans and general close quarters dictates that deep-draft ship movement to facilities above the bridges occurs only in the period around slack water and with the assistance of two or more tugs. Movement management assistance may be required to preclude hazardous meetings. Navigational assistance is not feasible because of the narrowness of the waterway.

3.0 PORTSMOUTH VTS DESIGN

3.1 INTRODUCTION

A detailed survey of the Port of Portsmouth is the basis for this design. An approach to costing VTS systems is outlined in Vol. III, Technical Supplement and a method of categorizing surveillance sensors into "modules" has also been developed. These modules are defined in terms of cost and performance and are to be applied to all VTS designs in this study. The applicability of Automatic Dependent Surveillance (ADS) technology is also discussed in this report. The three sub-zones defined in the harbor survey remain the same.

Traffic management requirements for each sub-zone are developed from PAI analysis. Table 3-1 lists in tabular form a summation of the problems identified and the management required by sub-zone.

The hardware and software selected for this design provide the level of surveillance justified by the problems identified in each sub-zone. A secondary consideration is to locate all VTS assets so that they are sufficient for the sub-zone in question and can contribute to adjoining sub-zones to achieve maximum usage. All specific equipments are then selected based on perceived surveillance requirements and overall VTS system architecture.

3.1.1 VTS Design Approach

The choice of surveillance sensors is dependent on the VTS mission. For the purposes of this design, the VTS mission is defined as that which insures the safety of navigation and the protection of the environment. In order to accomplish this mission, mandatory participation of all vessels over 20 meters is essential. The Vessel Traffic Center (VTC) must provide navigation safety advice to all vessels. The VTS in the United States will have no facilitation of commerce role nor will it offer piloting assistance of any kind.

TABLE 3-1. PORTSMOUTH, NH PROBLEM AREA IDENTIFIERS

PAI	LOCATION	PROBLEM	MANAGEMENT
I	Seaward Approaches	Data catchment area for inbound shipping.	Have real-time knowledge of vessel movements, locations through reporting. Enter inbound shipping information into database.
II	Portsmouth Entrance	Navigational hazards, potential congestion.	Have real-time knowledge of vessel movements, locations. Provide navigational assistance and movement management advice.
III	Portsmouth	Potential congestion and difficult meetings.	Have real-time knowledge of vessel movements and locations. Provide movement management advice.

The primary criteria for selection of adequate surveillance sensors are:

- Percentage of vessels of the desired minimum size detected in designated surveillance areas
- Percentage of lost tracks
- Accuracy of the position and track obtained
- Reliability of the surveillance system
- Timeliness of the data obtained
- Ability to interpret and use the data obtained

Secondary criteria are:

- Cost of the VTS system -- reduction of manpower by the use of technology
- Expandability -- increased VTS responsibility, area, and/or support of other missions

Active surveillance sensors including radar, communications, and closed circuit television (CCTV) installations are used when detection and tracking of vessels is paramount to providing safety advice. These devices are considered fail safe in that it is known with certainty when they have failed. The performance characteristics of these sensors are known from operational VTS worldwide experience. In this design they are selected to assure that the necessary operational criteria identified for each sub-zone is realized.

Many dependent surveillance techniques are possible. These range from voice radio reporting of required VTS data to automatic position and identification recording devices that can be interrogated from shore known as Automatic Dependent Surveillance (ADS) devices. The position and/or movement reporting form of dependent surveillance is used extensively in existing VTS systems. The major regions of current use are those which do not require active surveillance. To apply ADS technology to a specific sub-zone within a VTS zone the following additional criteria must be considered:

- The number and class of vessels interacting in the sub-zone and which of these interactions are important to the VTS mission. Obviously all vessel classes of interest must be appropriately equipped. This requires that all vessels of the classes selected which will ever pass through this sub-zone must be equipped with an ADS device. This requirement to detect so many different vessels argues

against the use of ADS. In areas where only one class of vessel is of interest, ADS is more easily implemented.

o The interactions or transits to be monitored must not demand that the surveillance be fail safe, i.e. positively detecting failures. This type of surveillance is related to position reporting in that it may not always function or be used properly and the VTS has limited control over its operation.

o It must be determined that if active surveillance is not justified, the additional information obtained from ADS over position reporting is necessary.

o If the class or group of vessels to be monitored is a "controllable" group, ADS can be easily implemented and satisfactory operation more readily achieved. Controllable means a clearly defined subset of vessels, e.g. a specific barge company; vessels carrying a specific cargo, etc.

o The number of different vessels in each class of interest that passes through the sub-zone in question must be determined. This number must be known to accurately estimate the cost of selecting this option for this sub-zone.

o A specific ADS solution for one sub-zone in one harbor may affect all the VTS designs for all the other sub-zones in all the other harbors.

3.1.2 Assumptions

The design of this VTS system starts with a set of assumptions based on the detailed survey and other data. These assumptions are as follows:

o As recommended by the IMO, all vessels of 20 meters or more in length are required to participate in the VTS. Participation is defined (at a minimum) as monitoring the VTS frequency and reporting as required.

o The VTS system is implemented with the cooperation and assistance of the port authorities, pilots associations, and marine exchange, if any. The existing facilities, services, and procedures established and operated by these organizations are major elements of an integrated VTS system as defined in the IMO VTS Guidelines.

o The life-cycle of all system hardware is ten years.

3.2 DESIGN DECISIONS (FIGURE 3-1)

3.2.1 General

Examination of the traffic levels, geographical features and identified problem areas in the port leads to the following selection and location of sensor hardware.

3.2.2 Hardware Location and Selection

3.2.2.1 Sub-Zone III

Fort Point Site	1 Module 1 radar
	1 Module 10 VHF
	1 Module 11 VHF
	1 Module 13 MET
Spinney Creek Site	1 Module 10 VHF

3.2.3 Vessel Traffic Center

The design of the hardware and software should be modern and capable of operating with reduced staff levels and no loss of effectiveness. One watchstander with an integrated data workstation and decision aiding software can effectively manage the activity in this port. This Vessel Traffic Center concept demands that the watchstander be separated from any other harbor/port information requests. The Center must be structured so that such requests are controlled by a bulletin board type interface. One officer-in-charge and one clerk are also required for the proper administration of the facility.

The Vessel Traffic Center is located on New Castle Island, in a location with good visual surveillance of the harbor entrance. The center is to employ the following equipment:

3.2.3.1 VTS Console

This console provides total data integration from all sensors in all sectors. These data are graphically shown on raster scan, high light level, color displays. A data display is also provided. Console design architecture is general purpose computer based, open architecture, bus organized, allowing operation of the system as a local area network (LAN). Data interchange with other facilities by modem is provided as well as interface with the U.S. Coast Guard standard terminal. The design allows board level modification and expansion. Features of the software and hardware provided are:

- o Software written in a high level language.
- o Software providing the total integration of data from all VTS sensors.

Surveillance Modules Sub Zones	RADAR						[illegible]			VHF		MET.		HYD.		DF	CCTV		COMMENTS
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
I																			Comms coverage from Sub-zone III
II																			Comms coverage from Sub-zone III
III	1									2	1		1						

FIGURE 3-1. PORTSMOUTH, NH SURVEILLANCE SURVEY

- Layering of data in at least four layers to be operator selectable.

- The ability to sector data including sector to sector handoff of targets.

- The ability to accept external digital data derived from transmissions of shipboard transponders or other sources and integrate the information with all other sensor data.

- Automatic and/or manual acquisition of radar targets including automatic tracking and target ID assignments. Guard zones with automatic acquisition of all targets entering the zone.

- Several warning levels of vessel interaction designed to direct attention to developing situations rather than a simple CPA alarm strategy.

- Complete vessel monitoring and alarm capability including anchor watch, CPA, TCPA, track history, adjustable target velocity vectors, restricted area penetration and maneuvering monitor is provided. Additional warning and/or alarm features allowed by programming changes in high level language.

- Complete modern color graphics capability with offset and zoom

- Complete harbor navigation aid monitoring capability including buoy position, light status, etc.

- Remote control of all radars and radar interfaces as well as radar data processing including site-to-site integration, clutter suppression, scan conversion and target extraction.

- Complete track projection capability which can predict and/or analyze future interactions based on current position, destination and velocity.

- The capability of constructing a complete vessel data base and interfacing it to the real-time data display from the VTS sensors.

3.2.3.2 Communications Console

This console is capable of remotely operating the proposed transmitting/receiving sites and allowing transmission and monitoring on all required frequencies. The console provides two operating positions each to be capable of complete communications control. It is capable of modular expansion if other remote communications sites are added.

3.2.3.3 Supervisor Control and Data Acquisition (SCADA) Equipment

A SCADA capability is provided to the major module level at remote sites so that the watchstander can determine the status of the entire VTS system. A graphic readout is provided in block diagram form indicating operational status of all elements in the system. Security monitoring of remote sites is also included.

3.2.3.4 Recording Equipment

Time synchronized video and audio recording equipment is to be provided. This equipment is capable of recording and playing back the data presented to the VTS watchstander and his reaction to the situation. An extra set of recording equipment is to be installed for redundancy purposes.

3.3 COST ESTIMATES

3.3.1 General

Vol. III, Technical Supplement discusses a generalized approach to estimating VTS system costs. This approach is based on interviews with system designers and purchasers of recently constructed systems. The cost of this VTS system has been estimated using this approach and is detailed below. The assumptions made in estimating these costs are listed in Paragraph 3.1.2.

3.3.2 Hardware (x $1000)

<u>Vessel Traffic Center</u>	non-recurring	recurring(10-yr)
VTS Console (1 workstation & all software)	500	
Communications console	100	
SCADA Equipment (1 radar site)	200	
Recording Equipment	50	
Sub-total:	850	400

<u>Sub-Zone I--Seaward Approaches (NOAA Chart 13278)</u>

Comms coverage in Sub-Zone II.

<u>Sub-Zone II--Portsmouth Entrance (NOAA Chart 13278 & 13283)</u>

Comms/radar coverage from Sub-Zone III.

Sub-Zone III--Portsmouth (NOAA Charts 13283 & 13285)

1 Module 1 radar	310	310
2 Module 10 VHF	38	26
1 Module 11 VHF	48	20
1 Module 13 MET	40	5
Sub-total:	436	361
HARDWARE TOTALS:	1286	761

3.3.3 Project Totals (x $1000)

Non-recurring

Hardware	$ 1286
Management, Engineering, etc. (50%) Assumptions: Turnkey system, Procurement by integ.contractor, good manufacturer support, some software provided, System Manual required	643
Installation site integration (15%) Assumptions: Complete installation by contractor, remote access no serious problem, many widespread sites	193
Spares & Training (10%)	129
Civil Engineering a VTC at New Castle Island, 1 radar site, remote comms and WX sensors installations land acquisition	750
PROJECT ESTIMATE:	3001
Data Base Management System	300
TOTAL: (non-recurring)	$3301

Recurring (10 year)

Hardware	761
1 Watchstander x 5 = 5 man/years @ 50K x 10	2500
1 Officer-in-Charge	500
1 Clerk	500
TOTAL: (recurring) (10-year life)	$ 4261
TOTAL 10-YEAR PROJECT COST:	$ 7561

REFERENCES

1. United States Coast Pilot, Volume 1, Atlantic Coast: Eastport to Cape Cod, 25th Edition, NOAA, Washington, D.C., pp. 172-173.

2. Ibid, pp. 174 and 177.

3. Final Report, National Vessel Traffic Services Study (TP5965E), Canadian Coast Guard, Ottawa 1984, pp. 89-91.

GLOSSARY

ADS: Automatic Dependent Surveillance

ARPA: Automatic Radar Plotting Aid.

"CONFINED-COMPLEX": a combination of terms relating to the geography and the nature of the interactions between ships. See Final Report National Vessel Traffic Services Study (TP-5965E), Canadian Coast Guard, Ottawa, October 1984, pp.89-91.

"CONFINED-SIMPLE": a combination terms relating to the geography and the nature of the interactions between ships. See Final Report National Vessel Traffic Services Study (TP-5965E), Canadian Coast Guard, Ottawa, October 1984, pp.89-91.

COTP: Captain of the Port

CCTV: closed circuit television

COLREGS LINE: a demarcation line delineating those waters upon which international regulations for the prevention of collisions at sea apply.

CPA: closest point of approach

DBMS: data base management system

DF: direction finder

FAA: Federal Aviation Administration

GIS: Geographic Information System

ICW: Intracoastal Waterway

IMO: International Maritime Organization

KW: Kilowatt

LAN: local area network

LLOYD'S LIST: a listing of all merchant vessels of the world including their physical characteristics. Published by Lloyd's of London.

LNG: liquified natural gas

NOAA: National Oceanic and Atmospheric Administration

"OPEN-COMPLEX": a combination of terms relating to the geography and the nature of the interactions between ships. See Final Report National Vessel Traffic Services Study (TP-5965E), Canadian Coast Guard, Ottawa, October 1984, pp. 89-91.

"OPEN-SIMPLE": a combination of terms relacing to the geography and the nature of the interactions between ships. See Final Report National Vessel Traffic Services Study (TP-5965E), Canadian Coast Guard, Ottawa, October 1984, pp. 89-91.

PAI: Problem Area Identifier

PRECAUTIONARY AREA: an area normally an intersection, entrance to, or exit from a traffic separation scheme where vessel interactions are unpredictable

SCADA: Supervisor Control and Data Acquisition

TCPA: time of closest point of approach

TRAFFIC SEPARATION SCHEME: routes incorporating traffic separation to increase the safety of navigation, particularly in converging areas of high traffic density.

VHF: very high frequency

VTC: vessel traffic center

VTS: vessel traffic services

STUDY ZONE INPUT DATA AND OUTPUT STATISTICS

Appendix R Zone 18 Portsmouth, NH

TABLE 1 Assignment of COE Waterway Codes to Subzones 8/06/91

COE Waterway		Name
Subzone 1801A		
135	A	PORTSMOUTH HARBOR, N. H.
137	A	ISLE OF SHOALS HARBOR, ME. AND N. H.
Subzone 1802B		
135	A	PORTSMOUTH HARBOR, N. H.
Subzone 1803D		
135	A	PORTSMOUTH HARBOR, N. H.

Appendix R Zone 18 Portsmouth, NH 7/15/91

TABLE 2 Base Year 1987 Cargo Tons by Subzone, Commodity, and Vessel Type

Subzone 1801A

Comm. Code	Name	Dry Cargo	Tanker	Dry Cargo Barge Tow	Tanker Barge Tow	Total
1	FARM PRODUCTS	1,323	0	0	0	1,323
3	FISHERIES PRODUCTS	80	0	0	0	80
4	MINING PRODUCTS, NEC	664,703	0	0	0	664,703
5	PROC. FOODS & MFTRS, NEC	228,788	0	0	0	228,788
6	WASTE OF MANUFACTURING	288,938	0	0	0	288,938
2871	NITROGEN CHEM FERTILIZER	4,519	0	0	0	4,519
2911	GASOLINE, INCL NATURAL	0	193,463	0	10,959	204,422
2912	JET FUEL	0	95,741	0	5,424	101,165
2913	KEROSENE	0	59,556	0	17,419	76,975
2914	DISTILLATE FUEL OIL	0	913,363	0	62,160	975,523
2915	RESIDUAL FUEL OIL	0	642,701	0	36,242	678,943
2921	LIQUI PETR-COAL-NATR GAS	0	261,426	0	14,809	276,235
	Subzone Total :	1,188,351	2,166,250	0	147,013	3,501,614

Subzone 1802B

Comm. Code	Name	Dry Cargo	Tanker	Dry Cargo Barge Tow	Tanker Barge Tow	Total
1	FARM PRODUCTS	1,323	0	0	0	1,323
3	FISHERIES PRODUCTS	80	0	0	0	80
4	MINING PRODUCTS, NEC	664,703	0	0	0	664,703
5	PROC. FOODS & MFTRS, NEC	228,788	0	0	0	228,788
6	WASTE OF MANUFACTURING	288,938	0	0	0	288,938
2871	NITROGEN CHEM FERTILIZER	4,519	0	0	0	4,519
2911	GASOLINE, INCL NATURAL	0	193,463	0	10,959	204,422
2912	JET FUEL	0	95,741	0	5,424	101,165
2913	KEROSENE	0	59,556	0	17,419	76,975
2914	DISTILLATE FUEL OIL	0	913,363	0	62,160	975,523
2915	RESIDUAL FUEL OIL	0	642,701	0	36,242	678,943
2921	LIQUI PETR-COAL-NATR GAS	0	261,426	0	14,809	276,235
	Subzone Total :	1,188,351	2,166,250	0	147,013	3,501,614

Subzone 1803D

Comm. Code	Name	Dry Cargo	Tanker	Dry Cargo Barge Tow	Tanker Barge Tow	Total
1	FARM PRODUCTS	1,323	0	0	0	1,323
3	FISHERIES PRODUCTS	80	0	0	0	80
4	MINING PRODUCTS, NEC	664,703	0	0	0	664,703
5	PROC. FOODS & MFTRS, NEC	228,788	0	0	0	228,788
6	WASTE OF MANUFACTURING	288,938	0	0	0	288,938
2871	NITROGEN CHEM FERTILIZER	4,519	0	0	0	4,519
2911	GASOLINE, INCL NATURAL	0	193,463	0	10,959	204,422
2912	JET FUEL	0	95,741	0	5,424	101,165
2913	KEROSENE	0	59,556	0	17,419	76,975
2914	DISTILLATE FUEL OIL	0	913,363	0	62,160	975,523
2915	RESIDUAL FUEL OIL	0	642,701	0	36,242	678,943
2921	LIQUI PETR-COAL-NATR GAS	0	261,426	0	14,809	276,235
	Subzone Total :	1,188,351	2,166,250	0	147,013	3,501,614

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Appendix R ZONE 18 Portsmouth, NH

TABLE 3 Base Year (1987)
Vessel Transits by Subzone, Vessel Type, and Size.

Vessel Type	Large	Medium	Small	Total
Subzone : 1801A				
Passenger	0	0	1,935	1,935
Dry Cargo	32	60	2,664	2,756
Tanker	73	102	32	207
Dry Cargo Barge Tow	4	0	8	12
Tanker Barge Tow	50	0	111	161
Tug/Tow Boat	0	0	111	111
Subzone Total:	159	162	4,861	5,182
Subzone : 1802B				
Passenger	0	0	1,935	1,935
Dry Cargo	32	60	1,244	1,336
Tanker	73	102	32	207
Dry Cargo Barge Tow	4	0	8	12
Tanker Barge Tow	50	0	111	161
Tug/Tow Boat	0	0	111	111
Subzone Total:	159	162	3,441	3,762
Subzone : 1803D				
Passenger	0	0	1,370	1,370
Dry Cargo	32	60	1,244	1,336
Tanker	73	102	32	207
Dry Cargo Barge Tow	4	0	8	12
Tanker Barge Tow	50	0	111	161
Tug/Tow Boat	0	0	111	111
Subzone Total:	159	162	2,876	3,197

Note: Sum of all vessel transits within each study subzone.

Appendix R ZONE 18 Portsmouth, NH

TABLE 3 Base Year (1987)
Vessel Transits by Suzone, Vessel Type, Size.

ZONE TOTALS

ZONE 18 Portsmouth, NH

Vessel Type	Large	Medium	Small	Total
Passenger	0	0	1,935	1,935
Dry Cargo	32	60	2,664	2,756
Tanker	73	102	32	207
Dry Cargo Barge Tow	4	0	8	12
Tanker Barge Tow	50	0	111	161
Tug/Tow Boat	0	0	111	111
Zone Total:	159	162	4,861	5,182

Note: Sum of all arrivals/departures to/from all terminals within the Study Zone.

Appendix R Zone 18 Portsmouth, NH

TABLE 4 Barges Per Tow - Average Factors by COE Waterway 8/6/91

COE Code	Waterway Name	Dry Barge	Tank Barge
SUBZONE	All Subzones within this Zone	1	1

NOTE: Average size of tows arriving/departing terminals within the waterway. Sizes of other tows transiting the area may differ.

Appendix R Zone 18 Portsmouth, NH

TABLE 5 Other Local Vessels by Subzone 7/21/91

Subzone	Name	Number of Vessels	Vessels per Square Mile
1801A		2,733	42.05
1803D		6,833	1,423.54
1804F		6,833	5,256.15
	Total for Zone	16,399	220.42

Note: State registered (1989/90) vessels estimated to be operated within the Subzone.

7/24/91

Appendix R ZONE 18 Portsmouth, NH

TABLE 6.1 Forecast 1995
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 1801A				
Passenger	0	0	1,973	1,973
Dry Cargo	43	91	3,291	3,425
Tanker	76	111	33	220
Dry Cargo Tow	0	0	9	9
Tanker Tow	52	0	121	173
Tug/Tow Boat	0	0	117	117
Subzone Total:	171	202	5,544	5,917
Subzone : 1802B				
Passenger	0	0	1,973	1,973
Dry Cargo	43	91	1,703	1,837
Tanker	76	111	33	220
Dry Cargo Tow	0	0	9	9
Tanker Tow	52	0	121	173
Tug/Tow Boat	0	0	117	117
Subzone Total:	171	202	3,956	4,329
Subzone : 1803D				
Passenger	0	0	1,397	1,397
Dry Cargo	43	91	1,703	1,837
Tanker	76	111	33	220
Dry Cargo Tow	0	0	9	9
Tanker Tow	52	0	121	173
Tug/Tow Boat	0	0	117	117
Subzone Total:	171	202	3,380	3,753

Note: Sum of all vessel transits within each study subzone.

Appendix R ZONE 18 Portsmouth, NH

TABLE 5.2 Forecast 2000
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 1801A				
Passenger	0	0	2,012	2,012
Dry Cargo	53	121	3,780	3,954
Tanker	80	118	34	232
Dry Cargo Tow	0	0	9	9
Tanker Tow	55	0	128	183
Tug/Tow Boat	0	0	134	134
Subzone Total:	188	239	6,097	6,524
Subzone : 1802B				
Passenger	0	0	2,012	2,012
Dry Cargo	53	121	2,117	2,291
Tanker	80	118	34	232
Dry Cargo Tow	0	0	9	9
Tanker Tow	55	0	128	183
Tug/Tow Boat	0	0	134	134
Subzone Total:	188	239	4,434	4,861
Subzone : 1803D				
Passenger	0	0	1,424	1,424
Dry Cargo	53	121	2,117	2,291
Tanker	80	118	34	232
Dry Cargo Tow	0	0	9	9
Tanker Tow	55	0	128	183
Tug/Tow Boat	0	0	134	134
Subzone Total:	188	239	3,846	4,273

Note: Sum of all vessel transits within each study subzone.

7/24/91

Appendix R ZONE 18 Portsmouth, NH

TABLE 6.3 Forecast 2005
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 1801A				
Passenger	0	0	2,060	2,060
Dry Cargo	68	165	4,424	4,657
Tanker	84	126	36	246
Dry Cargo Tow	0	0	10	10
Tanker Tow	58	0	136	194
Tug/Tow Boat	0	0	152	152
Subzone Total:	210	291	6,818	7,319
Subzone : 1802B				
Passenger	0	0	2,060	2,060
Dry Cargo	68	165	2,693	2,926
Tanker	84	126	36	246
Dry Cargo Tow	0	0	10	10
Tanker Tow	58	0	136	194
Tug/Tow Boat	0	0	152	152
Subzone Total:	210	291	5,087	5,588
Subzone : 1803D				
Passenger	0	0	1,458	1,458
Dry Cargo	68	165	2,693	2,926
Tanker	84	126	36	246
Dry Cargo Tow	0	0	10	10
Tanker Tow	58	0	136	194
Tug/Tow Boat	0	0	152	152
Subzone Total:	210	291	4,485	4,986

Note: Sum of all vessel transits within each study subzone.

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Appendix R ZONE 18 Portsmouth, NH

TABLE 6.4 Forecast 2010
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 1801A				
Passenger	0	0	2,108	2,108
Dry Cargo	88	226	5,280	5,594
Tanker	88	134	37	259
Dry Cargo Tow	0	0	10	10
Tanker Tow	60	0	145	205
Tug/Tow Boat	0	0	179	179
Subzone Total:	236	360	7,759	8,355
Subzone : 1802B				
Passenger	0	0	2,108	2,108
Dry Cargo	88	226	3,491	3,805
Tanker	88	134	37	259
Dry Cargo Tow	0	0	10	10
Tanker Tow	60	0	145	205
Tug/Tow Boat	0	0	179	179
Subzone Total:	236	360	5,970	6,566
Subzone : 1803D				
Passenger	0	0	1,493	1,493
Dry Cargo	88	226	3,491	3,805
Tanker	88	134	37	259
Dry Cargo Tow	0	0	10	10
Tanker Tow	60	0	145	205
Tug/Tow Boat	0	0	179	179
Subzone Total:	236	360	5,355	5,951

Note: Sum of all vessel transits within each study subzone.

Appendix R ZONE 18 Portsmouth, NH

TABLE 6.5 Forecast 1995 - 2010 Vessel Transits by Vessel Type and Size

Vessel Type	Large	Medium	Small	Total
	1995 FORECASTED ZONE TOTALS			
Passenger	0	0	1,973	1,973
Dry Cargo	39	82	3,127	3,248
Tanker	76	111	33	220
Dry Cargo Tow	0	0	9	9
Tanker Tow	52	0	121	173
Tug/Tow Boat	0	0	117	117
1995 Zone Total:	167	193	5,380	5,740
	2000 FORECASTED ZONE TOTALS			
Passenger	0	0	2,012	2,012
Dry Cargo	45	103	3,460	3,608
Tanker	80	118	34	232
Dry Cargo Tow	0	0	9	9
Tanker Tow	55	0	128	183
Tug/Tow Boat	0	0	134	134
2000 Zone Total:	180	221	5,777	6,178
	2005 FORECASTED ZONE TOTALS			
Passenger	0	0	2,060	2,060
Dry Cargo	58	135	3,942	4,135
Tanker	84	126	36	246
Dry Cargo Tow	0	0	10	10
Tanker Tow	58	0	136	194
Tug/Tow Boat	0	0	152	152
2005 Zone Total:	200	261	6,336	6,797
	2010 FORECASTED ZONE TOTALS			
Passenger	0	0	2,108	2,108
Dry Cargo	75	186	4,656	4,917
Tanker	88	134	37	259
Dry Cargo Tow	0	0	10	10
Tanker Tow	60	0	145	205
Tug/Tow Boat	0	0	179	179
2010 Zone Total:	223	320	7,135	7,678

Note: Sum of all arrivals/departures to/from all terminals within the study zone.

TABLE 7 Vessel Casualty History (10 Year Totals) by Subzone, Vessel Type and Size, and Casualty Type

Vessel Type	Size	Collisions	Rammings	Groundings	Other	Total
Subzone: 1804F						
Other	Small	0	0	1	0	1
Subzone Totals:		0	0	1	0	1
Zone Totals:		0	0	1	0	1

Note: OTHER equals barge breakaways and weather caused vessel casualties.

APPENDIX TABLE R-8 ZONE 18, PORTSMOUTH, NH - VTS LEVELS IN OPERATION

(Not Applicable to This Sub-Zone.)

APPENDIX TABLE R-9 ZONE 18, PORTSMOUTH, NH
CANDIDATE VTS DESIGN - 1995-2010

UNITS

1 Radar Module 1 - Average Performance
0 Radar Module 2 - Average Performance
0 Radar Module 3 - High Performance
0 Radar Module 4 - High Performance
0 Radar Module 5 - Special Purpose
0 Radar Module 6 - Special Purpose
0 ADS Module 7 - Active Radar Transponder (Type 1)
0 ADS Module 8 - Positional Transponder, Small Area, Very High Accuracy (Type 5)
0 ADS Module 9 - Positional Transponder, Small Area, High Accuracy (Type 6)
2 VHF Module 10 - Low power VHF Transmitting/ Receiving Facility
1 VHF Module 11 - High power VHF Transmitting/ Receiving Facility
0 Meteorological Module 12 - Air temperature, wind direction and speed
1 Meteorological Module 13 - Air temperature, wind direction and speed, visibility
0 Hydrological Module 14 - Water Temperature and Depth
0 Hydrological Module 15 - Water Temperature, Depth and Current
0 VHF/DF MODULE 16 - Line of position measurement to 2 degree RMS
0 CCTV MODULE 17 - Fixed Focus CCTV via Telephone Lines
0 CCTV MODULE 18 - Remotely Controllable CCTV via

TABLE 10A

Avoided Vessel Casualties 1996 - 2010
Candidate VTS Systems

7/31/91

Counts

Vessel Type	Size	Collision	Ramming	Grounding	Total
Passenger	Small	.00	.00	.00	.01
Dry Cargo	Large	.00	.00	.00	.01
Dry Cargo	Medium	.00	.00	.00	.00
Dry Cargo	Small	.02	.00	.00	.02
Tanker	Large	.01	.00	.01	.02
Tanker	Medium	.00	.00	.00	.00
Tanker	Small	.00	0.00	.00	.00
Dry Cargo Barge T	Small	.00	.00	.00	.00
Tanker Barge Tow	Large	.00	.00	.00	.00
Tanker Barge Tow	Small	.01	.00	.00	.01
Tug/Tow Boat	Small	.00	.00	.00	.00
		.04	.01	.03	.08

Undiscounted Total Dollar Losses (1,000)

Vessel Type	Size	Collision	Ramming	Grounding	Total
Passenger	Small	4	1	3	7
Dry Cargo	Large	4	1	1	6
Dry Cargo	Medium	4	1	0	5
Dry Cargo	Small	11	1	2	14
Tanker	Large	11	3	5	18
Tanker	Medium	2	0	0	2
Tanker	Small	0	0	0	0
Dry Cargo Barge T	Small	0	0	0	0
Tanker Barge Tow	Large	0	0	0	0
Tanker Barge Tow	Small	0	0	0	1
Tug/Tow Boat	Small	0	0	0	0
		37	6	12	55

Note: In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 11 Avoided Fatalities 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Small	.00	.00	.00	.00
Dry Cargo	Large	.00	.00	.00	.00
Dry Cargo	Medium	.00	.00	.00	.00
Dry Cargo	Small	.00	.00	.00	.00
Tanker	Small	.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	.00	.00	.00	.00
Tanker Barge Tow	Small	.00	.00	.00	.00
Tug/Tow Boat	Small	.00	.00	.00	.00
Totals		.00	.00	.00	.00
Candidate VTS Design - Dollars					
Passenger	Small	425.55	66.13	465.62	957.29
Dry Cargo	Large	537.16	91.57	661.32	1,290.04
Dry Cargo	Medium	503.32	81.27	212.88	797.46
Dry Cargo	Small	1,593.01	187.53	304.23	2,084.76
Tanker	Small	.66	0.00	.55	1.21
Dry Cargo Barge Tow	Small	1.16	.36	.49	2.01
Tanker Barge Tow	Small	17.49	3.13	12.40	33.02
Tug/Tow Boat	Small	1.11	.41	1.07	2.59
Totals		3,079.45	430.40	1,658.54	5,168.39

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 12 Avoided Human Injuries 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Small	.00	.00	.00	.01
Dry Cargo	Large	.00	.00	.00	.00
Dry Cargo	Medium	.00	.00	.00	.00
Dry Cargo	Small	.01	.00	.00	.02
Tanker	Small	.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	.00	.00	.00	.00
Tanker Barge Tow	Small	.00	.00	.00	.00
Tug/Tow Boat	Small	.00	.00	.00	.00
Totals		.02	.00	.01	.02
Candidate VTS Design - Dollars					
Passenger	Small	801.31	124.52	876.76	1,802.60
Dry Cargo	Large	9.22	1.57	11.35	22.15
Dry Cargo	Medium	8.64	1.40	3.66	13.69
Dry Cargo	Small	2,999.66	353.12	572.86	3,925.64
Tanker	Small	1.16	0.00	.96	2.11
Dry Cargo Barge Tow	Small	2.03	.63	.86	3.51
Tanker Barge Tow	Small	30.56	5.47	21.67	57.69
Tug/Tow Boat	Small	1.94	.72	1.87	4.53
Totals		3,854.5[illegible]	487.43	1,489.98	5,831.93

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 13 Avoided Vessels Damaged 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Small	.00	.00	.00	.01
Dry Cargo	Large	.00	.00	.00	.00
Dry Cargo	Medium	.00	.00	.00	.00
Dry Cargo	Small	.01	.00	.00	.02
Tanker	Large	.01	.00	.00	.01
Tanker	Medium	.00	.00	.00	.00
Tanker	Small	.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	.00	.00	.00	.00
Tanker Barge Tow	Large	.00	.00	.00	.00
Tanker Barge Tow	Small	.00	.00	.00	.00
Tug/Tow Boat	Small	.00	.00	.00	.00
Totals		.04	.01	.01	.05
Candidate VTS Design - Dollars					
Passenger	Small	1,287.44	156.38	780.53	2,224.35
Dry Cargo	Large	1,561.28	254.70	217.71	2,033.68
Dry Cargo	Medium	1,767.36	273.10	49.01	2,089.46
Dry Cargo	Small	2,698.86	258.34	426.06	3,383.26
Tanker	Large	5,104.96	1,258.35	3,563.47	9,926.78
Tanker	Medium	797.81	79.74	244.61	1,122.16
Tanker	Small	13.12	0.00	14.14	27.26
Dry Cargo Barge Tow	Small	15.56	2.67	1.05	19.28
Tanker Barge Tow	Large	258.18	66.76	48.36	373.30
Tanker Barge Tow	Small	286.38	28.37	47.14	361.89
Tug/Tow Boat	Small	4.24	1.02	3.97	9.22
Totals		13,795.19	2,379.42	5,396.06	21,570.66

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 14 Avoided Cargo Damage/Loss 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Small	.00	.00	.00	.00
Dry Cargo	Large	.00	.00	.00	.00
Dry Cargo	Medium	.00	.00	.00	.00
Dry Cargo	Small	.01	.00	.00	.01
Tanker	Large	.00	.00	.00	.00
Tanker	Medium	.00	.00	.00	.00
Tanker	Small	.00	0.00	.00	.00
Dry Cargo Tow	Small	.00	.00	.00	.00
Tanker Tow	Large	.00	.00	.00	.00
Tanker Tow	Small	.00	.00	.00	.00
Tug/Tow Boat	Small	.00	.00	.00	.00
Totals		.01	.00	.00	.02
Candidate VTS Design - Dollars					
Passenger	Small	3.26	.40	1.76	5.41
Dry Cargo	Large	8.04	1.94	1.00	10.98
Dry Cargo	Medium	7.53	1.72	.30	9.56
Dry Cargo	Small	12.25	1.17	1.91	15.33
Tanker	Large	132.18	31.09	155.13	318.40
Tanker	Medium	6.09	.60	1.31	8.00
Tanker	Small	.17	0.00	.09	.25
Tanker Tow	Large	47.33	22.25	31.41	100.99
Tanker Tow	Small	89.24	15.96	25.77	130.97
Tug/Tow Boat	Small	.05	.01	.05	.11
Totals		306.12	75.15	218.74	600.01

Note1: Dollar values include bulk petroleum and chemical cargos only and all vessel fuels spilled. Dollar values exclude cargo loss/damage for non-tank vessel types.

Note2: In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 15 Avoided NavAid Damage 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Small	0.00	.00	.00	.00
Dry Cargo	Large	0.00	.00	.00	.00
Dry Cargo	Medium	0.00	.00	.00	.00
Dry Cargo	Small	0.00	.00	.00	.00
Tanker	Large	0.00	.00	.00	.00
Tanker	Medium	0.00	.00	.00	.00
Tanker	Small	0.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	0.00	.00	.00	.00
Tanker Barge Tow	Large	0.00	.00	.00	.00
Tanker Barge Tow	Small	0.00	.00	.00	.00
Tug/Tow Boat	Small	0.00	.00	.00	.00
Totals		0.00	.00	.00	.00
Candidate VTS Design - Dollars					
Passenger	Small	0.00	.44	.16	.60
Dry Cargo	Large	0.00	.31	.12	.43
Dry Cargo	Medium	0.00	.28	.04	.32
Dry Cargo	Small	0.00	1.26	.10	1.36
Tanker	Large	0.00	1.29	.41	1.70
Tanker	Medium	0.00	.10	.03	.13
Tanker	Small	0.00	0.00	.01	.01
Dry Cargo Barge Tow	Small	0.00	.07	.00	.08
Tanker Barge Tow	Large	0.00	.53	.04	.57
Tanker Barge Tow	Small	0.00	.61	.12	.73
Tug/Tow Boat	Small	0.00	.08	.01	.09
Totals		0.00	4.98	1.04	6.02

Note : *In Counts*, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 16 Avoided Bridge Damage 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Dry Cargo	Small	0.00	0.00	0.00	0.00
Totals		0.00	0.00	0.00	0.00
Candidate VTS Design - Dollars					
Dry Cargo	Small	0.00	0.00	0.00	0.00
Totals		0.00	0.00	0.00	0.00

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

Appendix R Zone 18 Portsmouth, NH
TABLE 17 Avoided Hazardous Commodity Spills 1996 - 2010 7/30/91

Commodity	Catastrophic	Large	Medium	Small	Total
Candidate Vts Design - Counts					
DISTILLATE FUEL OIL		0.00	0.00	.01	.01
RESIDUAL FUEL OIL		0.00	.00	.00	.00
	0.00	0.00	.00	.01	.01

Note: In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

Appendix R Zone 18 Portsmouth, NH
TABLE 18A Annual Benefit & Cost Streams 7/31/91
Candidate VTS Systems

Discounted to 1993

Year	Investment ($1,000)	Operation & Maintenance ($1,000)	Benefits ($1,000)
1993	3,301	0	0
1996	0	335	2
1997	0	305	2
1998	0	277	2
1999	0	252	2
2000	0	229	2
2001	0	208	2
2002	0	189	2
2003	0	172	1
2004	0	156	1
2005	0	142	1
2006	0	129	1
2007	0	118	1
2008	0	107	1
2009	0	97	1
2010	0	88	1
	3,301	2,806	23

Undiscounted

Year	Investment ($1,000)	Operation & Maintenance ($1,000)	Benefits ($1,000)
1993	3,301	0	0
1996	0	426	3
1997	0	426	3
1998	0	426	3
1999	0	426	3
2000	0	426	3
2001	0	426	3
2002	0	426	4
2003	0	426	4
2004	0	426	4
2005	0	426	4
2006	0	426	4
2007	0	426	4
2008	0	426	4
2009	0	426	4
2010	0	426	4
	3,301	6,392	55

APPENDIX R

ZONE 18 - PORTSMOUTH, NH

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Portsmouth Harbor (Port 18)

Port & Subzone	Species Category	Species Code	Species Name	Wildlife Abundance Tables Fish & Shellfish Grams per Square Meter Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
1801	101	1	American Shad	.0045	.0045	.0045	.0021
1801	101	2	Alewife	.2200	.2200	.2200	.1000
1801	102	3	Menhaden	2.8000	4.2000	2.8000	0.0000
1801	102	4	Atlantic Herring	.6300	.6300	.6300	.6300
1801	102	5	Butterfish	.0590	.0590	.0590	.0590
1801	102	6	Pollock	1.4000	1.4000	1.4000	1.4000
1801	102	7	Atlantic Mackerel	3.0000	3.0000	3.0000	3.0000
1801	102	32	King Mackerel	.0095	.0190	.0095	0.0000
1801	102	44	Striped Mullet	.0240	.0240	.0240	.0240
1801	103	8	Bluefish	.4100	.8400	.4100	0.0000
1801	103	9	Striped Bass	.0050	.0050	.0100	.0100
1801	103	10	Monkfish	.0810	.0810	.0810	.0810
1801	103	11	Weakfish	.0120	.1020	.0120	.0120
1801	104	12	Tuna	0.0000	.0930	0.0000	0.0000
1801	104	13	Swordfish	.0430	.0430	.0430	.0430
1801	104	14	Shark	.0042	.0042	.0042	.0042
1801	104	15	Dogfish	1.0300	1.0300	1.0300	1.0300
1801	106	21	Atlantic Cod	.5900	.5900	.5900	.5900
1801	106	22	Haddock	.1200	.1200	.1200	.1200
1801	106	23	Redfish	.1400	.1400	.1400	.1400
1801	106	24	Silver Hake	.7900	.7900	.7900	.7900
1801	106	25	Red Hake	.5900	.5900	.5900	.5900
1801	106	26	White Hake	.3200	.3200	.3200	.3200
1801	106	27	Scup	.2000	.2000	.2000	.2000
1801	106	28	Tilefish	.0160	.0160	.0160	.0160
1801	106	29	Black Sea Bass	.0170	.0170	.0170	.0170
1801	106	30	Atlantic Wolffish	.0140	.0140	.0140	.0140
1801	106	35	Atlantic Croaker	.0240	.0240	.0240	.0240
1801	106	66	Cusk	.2800	.2800	.2800	.2800
1801	106	67	Tautog	1.1000	1.1000	1.1000	1.1000
1801	106	199	Other	.2500	.2500	.2500	.2500
1801	106	199	Other Fish	.0750	.0750	.0750	.0750
1801	107	202	Ocean Quahog	3.4000	3.4000	3.4000	3.4000
1801	107	203	Atlantic Sea Scallop	.1100	.1100	.1100	.1100
1801	107	299	Other Invertebrates	.1100	.1100	.1100	.1100
1801	107	299	Other Invertebrates	.1800	.1800	.1800	.1800
1801	108	204	American Lobster	.3300	.3300	.3300	.3300
1801	108	204	American Lobster	.4600	.4600	.4600	.4600
1801	108	205	Northern Shrimp	.0280	.0280	.0280	.0280
1801	108	205	Northern Shrimp	.0560	.0560	.0560	.0560
1801	108	206	Red Crab	.1200	.1200	.1200	.1200
1801	109	207	Atlantic Squid	.1700	.1700	.1700	.1700
1801	109	207	Atlantic Squid	.3900	.3900	.3900	.3900
1802	101	1	American Shad	.0045	.0045	.0045	.0021
1802	101	2	Alewife	.2200	.2200	.2200	.1000
1802	102	3	Menhaden	2.8000	4.2000	2.8000	0.0000
1802	102	4	Atlantic Herring	.6300	.6300	.6300	.6300
1802	102	5	Butterfish	.0590	.0590	.0590	.0590
1802	102	6	Pollock	1.4000	1.4000	1.4000	1.4000
1802	102	7	Atlantic Mackerel	3.0000	3.0000	3.0000	3.0000
1802	102	32	King Mackerel	.0095	.0190	.0095	0.0000
1802	102	44	Striped Mullet	.0240	.0240	.0240	.0240
1802	103	8	Bluefish	.4100	.8400	.4100	0.0000
1802	103	9	Striped Bass	.0050	.0050	.0100	.0100
1802	103	10	Monkfish	.0810	.0810	.0810	.0810

ZONE 18 - PORTSMOUTH, NH (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Wildlife Abundance Tables
Fish & Shellfish
Grams per Square Meter

Portsmouth Harbor (Port 18)

Port & Subzone	Species Category	Species Code	Species Name	Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
1802	103	11	Weakfish	.0120	.1020	.0120	.0120
1802	104	12	Tuna	0.0000	.0930	0.0000	0.0000
1802	104	13	Swordfish	.0430	.0430	.0430	.0430
1802	104	14	Shark	.0042	.0042	.0042	.0042
1802	104	15	Dogfish	1.0300	1.0300	1.0300	1.0300
1802	106	21	Atlantic Cod	.5900	.5900	.5900	.5900
1802	106	22	Haddock	.1200	.1200	.1200	.1200
1802	106	23	Redfish	.1400	.1400	.1400	.1400
1802	106	24	Silver Hake	.7900	.7900	.7900	.7900
1802	106	25	Red Hake	.5900	.5900	.5900	.5900
1802	106	26	White Hake	.3200	.3200	.3200	.3200
1802	106	27	Scup	.2000	.2000	.2000	.2000
1802	106	28	Tilefish	.0160	.0160	.0160	.0160
1802	106	29	Black Sea Bass	.0170	.0170	.0170	.0170
1802	106	30	Atlantic Wolffish	.0140	.0140	.0140	.0140
1802	106	35	Atlantic Croaker	.0240	.0240	.0240	.0240
1802	106	66	Cusk	.2800	.2800	.2800	.2800
1802	106	67	Tautog	1.1000	1.1000	1.1000	1.1000
1802	106	199	Other	.2500	.2500	.2500	.2500
1802	106	199	Other Fish	.0750	.0750	.0750	.0750
1802	107	202	Ocean Quahog	3.4000	3.4000	3.4000	3.4000
1802	107	203	Atlantic Sea Scallop	.1100	.1100	.1100	.1100
1802	107	299	Other Invertebrates	.1100	.1100	.1100	.1100
1802	107	299	Other Invertebrates	.1800	.1800	.1800	.1800
1802	108	204	American Lobster	.3300	.3300	.3300	.3300
1802	108	204	American Lobster	.4600	.4600	.4600	.4600
1802	108	205	Northern Shrimp	.0280	.0280	.0280	.0280
1802	108	205	Northern Shrimp	.0560	.0560	.0560	.0560
1802	108	206	Red Crab	.1200	.1200	.1200	.1200
1802	109	207	Atlantic Squid	.1700	.1700	.1700	.1700
1802	109	207	Atlantic Squid	.3900	.3900	.3900	.3900
1803	101	1	American Shad	.1200	.5800	0.0000	.0580
1803	101	2	Alewife	.4100	.4100	.4100	.4100
1803	101	31	Hickory Shad	.0120	.0060	0.0000	.0060
1803	102	2	Blueback Herring	.0010	.0010	.0010	.0010
1803	102	3	Menhaden	21.1000	21.1000	21.1000	21.1000
1803	102	4	Atlantic Herring	.0010	.0010	.0010	.0010
1803	102	7	Atlantic Mackerel	.0040	0.0000	0.0000	.0040
1803	102	32	King Mackerel	.0030	0.0000	0.0000	.0030
1803	102	33	Spanish Mackerel	.0210	0.0000	0.0000	.0211
1803	102	34	Harvestfish	.0010	.0010	.0010	.0010
1803	103	8	Bluefish	.2700	.3200	.3200	0.0000
1803	103	9	Striped Bass	.2600	.4700	.4200	.4200
1803	103	11	Weakfish	.3100	.3100	.3100	.0070
1803	106	24	Silver Hake	.0010	.0010	.0010	.0010
1803	106	25	Red Hake	.0040	.0020	.0030	.0030
1803	106	26	White Hake	.0090	.0140	.0050	0.0000
1803	106	29	Black Sea Bass	.0010	.0010	.0010	.0010
1803	106	35	Atlantic Croaker	.3700	.3700	.3700	0.0000
1803	106	36	Drum	.0020	.0020	.0020	0.0000
1803	106	37	Spot	.0960	.0490	0.0000	.0490
1803	106	38	Yellow Perch	.0020	.0020	.0020	.0020

APPENDIX R

ZONE 18 - PORTSMOUTH, NH (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Portsmouth Harbor (Port 18)

Wildlife Abundance Tables
Fish & Shellfish
Grams per Square Meter

Port & Subzone	Species Category	Species Code	Species Name	Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
1803	106	39	Carp	.0250	.0250	.0250	.0250
1803	106	40	Eel	.1400	.1400	.1400	.1400
1803	106	67	Tautog	1.1000	1.1000	1.1000	1.1000
1803	106	199	Other Fish	.7800	.7800	.7800	.7800
1803	107	212	Atlantic Oyster	1.9000	1.9000	1.9000	1.9000
1803	107	214	Conch	.0660	.0660	.0660	.0660
1803	108	204	American Lobster	.2200	.4400	.2200	0.0000
1803	108	209	Hard Blue Crab	4.1000	4.1000	4.1000	4.1000
1803	108	210	Soft Blue Crab	.2000	.2000	0.0000	0.0000
1803	109	207	Atlantic Squid	.0280	.1500	.1300	0.0000
1804	101	1	American Shad	.1200	.5800	0.0000	.0580
1804	101	2	Alewife	.4100	.4100	.4100	.4100
1804	101	31	Hickory Shad	.0120	.0060	0.0000	.0060
1804	102	2	Blueback Herring	.0010	.0010	.0010	.0010
1804	102	3	Menhaden	21.1000	21.1000	21.1000	21.1000
1804	102	4	Atlantic Herring	.0010	.0010	.0010	.0010
1804	102	7	Atlantic Mackerel	.0040	0.0000	0.0000	.0040
1804	102	32	King Mackerel	.0030	0.0000	0.0000	.0030
1804	102	33	Spanish Mackerel	.0210	0.0000	0.0000	.0211
1804	102	34	Harvestfish	.0010	.0010	.0010	.0010
1804	103	8	Bluefish	.2700	.3200	.3200	0.0000
1804	103	9	Striped Bass	.2600	.4700	.4200	.4200
1804	103	11	Weakfish	.3100	.3100	.3100	.0070
1804	106	24	Silver Hake	.0010	.0010	.0010	.0010
1804	106	25	Red Hake	.0040	.0020	.0030	.0030
1804	106	26	White Hake	.0090	.0140	.0050	0.0000
1804	106	29	Black Sea Bass	.0010	.0010	.0010	.0010
1804	106	35	Atlantic Croaker	.3700	.3700	.3700	0.0000
1804	106	36	Drum	.0020	.0020	.0020	0.0000
1804	106	37	Spot	.0960	.0490	0.0000	.0490
1804	106	38	Yellow Perch	.0020	.0020	.0020	.0020
1804	106	39	Carp	.0250	.0250	.0250	.0250
1804	106	40	Eel	.1400	.1400	.1400	.1400
1804	106	67	Tautog	1.1000	1.1000	1.1000	1.1000
1804	106	199	Other Fish	.7800	.7800	.7800	.7800
1804	107	212	Atlantic Oyster	1.9000	1.9000	1.9000	1.9000
1804	107	214	Conch	.0660	.0660	.0660	.0660
1804	108	204	American Lobster	.2200	.4400	.2200	0.0000
1804	108	209	Hard Blue Crab	4.1000	4.1000	4.1000	4.1000
1804	108	210	Soft Blue Crab	.2000	.2000	0.0000	0.0000
1804	109	207	Atlantic Squid	.0280	.1500	.1300	0.0000

APPENDIX R

ZONE 18 - PORTSMOUTH, NH (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Portsmouth Harbor		(Port 18)		Wildlife Abundance Tables Fish & Shellfish Larvae Numbers per Square Meter			
Port & Subzone	Species Category	Species Code	Species Name	Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
1801	202	1004	Atlantic Herring	.3000	0.0000	50.0000	5.0000
1801	202	1005	Butterfish	0.0000	.5000	0.0000	0.0000
1801	202	1006	Pollock	.5000	0.0000	5.0000	5.0000
1801	202	1007	Atlantic Mackerel	50.0000	5.0000	0.0000	0.0000
1801	202	1110	Sand Lance	.5000	0.0000	0.0000	50.0000
1801	203	1199	Larvae	.0110	.1700	.0054	0.0000
1801	205	1016	Yellowtail Flounder	.5000	5.0000	0.0000	0.0000
1801	205	1018	American Plaice	5.0000	0.0000	0.0000	0.0000
1801	205	1019	Witch Flounder	5.0000	0.0000	0.0000	0.0000
1801	206	1021	Atlantic Cod	.5000	0.0000	.0500	0.0000
1801	206	1023	Redfishes	0.0000	5.0000	0.0000	0.0000
1801	206	1024	Silver Hake	0.0000	5.0000	.5000	0.0000
1801	206	1026	Hake	0.0000	.5000	.0500	0.0000
1801	206	1255	Cunner	0.0000	50.0000	5.0000	0.0000
1801	207	1199	Larvae	2.0000	20.0000	2.0000	0.0000
1801	208	1199	Larvae	.0016	.0042	0.0000	0.0000
1802	202	1004	Atlantic Herring	.3000	0.0000	50.0000	5.0000
1802	202	1005	Butterfish	0.0000	.5000	0.0000	0.0000
1802	202	1006	Pollock	.5000	0.0000	5.0000	5.0000
1802	202	1007	Atlantic Mackerel	50.0000	5.0000	0.0000	0.0000
1802	202	1110	Sand Lance	.5000	0.0000	0.0000	50.0000
1802	203	1199	Larvae	.0110	.1700	.0054	0.0000
1802	205	1016	Yellowtail Flounder	.5000	5.0000	0.0000	0.0000
1802	205	1018	American Plaice	5.0000	0.0000	0.0000	0.0000
1802	205	1019	Witch Flounder	5.0000	0.0000	0.0000	0.0000
1802	206	1021	Atlantic Cod	.5000	0.0000	.0500	0.0000
1802	206	1023	Redfishes	0.0000	5.0000	0.0000	0.0000
1802	206	1024	Silver Hake	0.0000	5.0000	.5000	0.0000
1802	206	1026	Hake	0.0000	.5000	.0500	0.0000
1802	206	1255	Cunner	0.0000	50.0000	5.0000	0.0000
1802	207	1199	Larvae	2.0000	20.0000	2.0000	0.0000
1802	208	1199	Larvae	.0016	.0042	0.0000	0.0000
1803	202	1010	Sand lance	1.1120	.3706	0.0000	.7119
1803	202	1060	Pollock	.0819	0.0000	0.0000	.1003
1803	202	1104	Herring	.3207	.3207	.3207	.2328
1803	202	1121	Blenny	.1001	0.0000	0.0000	.4095
1803	202	1127	Silverside	.0067	.0067	0.0000	0.0000
1803	202	1248	Wrymouth	.0552	0.0000	0.0000	.1401
1803	203	1199	Larvae	.0640	1.1000	.0310	0.0000
1803	205	1020	Winter Flounder	.3082	.3082	0.0000	0.0000
1803	205	1251	Smooth Flounder	.0485	0.0000	0.0000	.0510
1803	206	1040	American Eel	.0145	0.0000	0.0000	0.0000
1803	206	1103	Smelt	.9618	.9618	0.0000	0.0000
1803	206	1109	Sculpin	.0068	.0068	.0068	0.0000
1803	206	1109	Sculpin	.7752	0.0000	0.0000	1.2073
1803	206	1112	Sea Snail	1.0191	0.0000	0.0000	.0760
1803	206	1114	Gunnel	2.4939	0.0000	3.2570	3.2570
1803	206	1199	Alligator Fish	.0338	0.0000	.0338	0.0000
1803	206	1199	Radiated Shanny	.4172	.4172	.4172	0.0000
1803	206	1244	Pipefish	.0060	.0060	0.0000	0.0000
1803	206	1259	Atlantic Tomcod	.0034	0.0000	.0034	.0364
1803	207	1199	Larvae	100.0000	1000.0000	100.0000	0.0000
1803	208	1199	Larvae	.0160	.0420	0.0000	0.0000

APPENDIX R

ZONE 18 - PORTSMOUTH, NH (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Portsmouth Harbor		(Port 18)		Wildlife Abundance Tables Fish & Shellfish Larvae Numbers per Square Meter			
Port & Subzone	Species Category	Species Code	Species Name	Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
1804	202	1010	Sand lance	1.1120	.3706	0.0000	.7119
1804	202	1060	Pollock	.0819	0.0000	0.0000	.1003
1804	202	1104	Herring	.3207	.3207	.3207	.2328
1804	202	1121	Blenny	.1001	0.0000	0.0000	.4095
1804	202	1127	Silverside	.0067	.0067	0.0000	0.0000
1804	202	1248	Wrymouth	.0552	0.0000	0.0000	.1401
1804	203	1199	Larvae	.0640	1.1000	.0310	0.0000
1804	205	1020	Winter Flounder	.3082	.3082	0.0000	0.0000
1804	205	1251	Smooth Flounder	.0485	0.0000	0.0000	.0510
1804	206	1040	American Eel	.0145	0.0000	0.0000	0.0000
1804	206	1103	Smelt	.9618	.9618	0.0000	0.0000
1804	206	1109	Sculpin	.0068	.0068	.0068	0.0000
1804	206	1109	Sculpin	.7752	0.0000	0.0000	1.2073
1804	206	1112	Sea Snail	1.0191	0.0000	0.0000	.0760
1804	206	1114	Gunnel	2.4939	0.0000	3.2570	3.2570
1804	206	1199	Alligator Fish	.0338	0.0000	.0338	0.0000
1804	206	1199	Radiated Shanny	.4172	.4172	.4172	0.0000
1804	206	1244	Pipefish	.0060	.0060	0.0000	0.0000
1804	206	1259	Atlantic Tomcod	.0034	0.0000	.0034	.0364
1804	207	1199	Larvae	100.0000	1000.0000	100.0000	0.0000
1804	208	1199	Larvae	.0160	.0420	0.0000	0.0000

ZONE 18 - PORTSMOUTH, NH (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Portsmouth Harbor (Port 18) Port & Subzone	Species Category	Species Code	Species Name	Wildlife Abundance Tables Birds Numbers per Square Kilometer Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
1801	111	517	Common Loon	.0200	0.0000	.0500	.0100
1801	111	517	Redthroated Loon	0.0000	0.0000	.0100	.0100
1801	113	530	Cormorant	.0900	0.0000	.0200	0.0000
1801	113	531	Gull	5.3000	3.7500	13.6900	10.1600
1801	113	532	Black Legged Kittiwake	1.7500	.0100	.5000	9.3100
1801	113	533	Least Tern	.0100	.0900	.0900	0.0000
1801	113	533	Tern	0.0000	.0100	0.0000	0.0000
1801	113	534	Cory's Shearwater	0.0000	.0700	1.4200	0.0000
1801	113	534	Greater Shearwater	.0200	2.8800	11.4700	.0100
1801	113	534	Manx Shearwater	0.0000	.0100	0.0000	0.0000
1801	113	534	Scoty Shearwater	.0800	.4100	.0100	0.0000
1801	113	535	Other Jaegers	0.0000	.0100	.0200	0.0000
1801	113	535	Parasitic Jaeger	0.0000	0.0000	.0100	0.0000
1801	113	535	Pomarine Jaeger	0.0000	.0100	.1400	0.0000
1801	113	535	Skua	0.0000	0.0000	.0100	0.0000
1801	113	536	Northern Fulmar	4.4600	.3700	.8400	8.7300
1801	113	537	Leach's Storm Petrel	.0100	2.5000	0.0000	0.0000
1801	113	537	Wilson's Storm Petrel	.1600	12.0300	.0900	0.0000
1801	113	538	Dovekie	.1900	0.0000	0.0000	.0500
1801	113	538	Large Alcid	.0900	0.0000	0.0000	.0800
1801	113	538	Murre	.1900	0.0000	0.0000	.0100
1801	113	538	Razorbill	.0200	0.0000	.0100	.0500
1801	113	539	Black Guillemot	0.0000	0.0000	0.0000	.0100
1801	113	540	Atlantic Puffin	0.0000	.0100	0.0000	.0200
1801	113	542	Other Phalaropes	.0100	.0300	.0100	.1000
1801	113	542	Red Phalarope	.1000	.0500	.0200	.0100
1801	113	542	Red-necked Phalarope	0.0000	.0800	.1200	.0600
1801	113	547	Northern Gannet	.1900	.0100	.5400	.3400
1802	111	517	Common Loon	.0200	0.0000	.0500	.0100
1802	111	517	Redthroated Loon	0.0000	0.0000	.0100	.0100
1802	113	530	Cormorant	.0900	0.0000	.0200	0.0000
1802	113	531	Gull	5.3000	3.7500	13.6900	10.1600
1802	113	532	Black Legged Kittiwake	1.7500	.0100	.5000	9.3100
1802	113	533	Least Tern	.0100	.0900	.0900	0.0000
1802	113	533	Tern	0.0000	.0100	0.0000	0.0000
1802	113	534	Cory's Shearwater	0.0000	.0700	1.4200	0.0000
1802	113	534	Greater Shearwater	.0200	2.8800	11.4700	.0100
1802	113	534	Manx Shearwater	0.0000	.0100	0.0000	0.0000
1802	113	534	Scoty Shearwater	.0800	.4100	.0100	0.0000
1802	113	535	Other Jaegers	0.0000	.0100	.0200	0.0000
1802	113	535	Parasitic Jaeger	0.0000	0.0000	.0100	0.0000
1802	113	535	Pomarine Jaeger	0.0000	.0100	.1400	0.0000
1802	113	535	Skua	0.0000	0.0000	.0100	0.0000
1802	113	536	Northern Fulmar	4.4600	.3700	.8400	8.7300
1802	113	537	Leach's Storm Petrel	.0100	2.5000	0.0000	0.0000
1802	113	537	Wilson's Storm Petrel	.1600	12.0300	.0900	0.0000
1802	113	538	Dovekie	.1900	0.0000	0.0000	.0500
1802	113	538	Large Alcid	.0900	0.0000	0.0000	.0800
1802	113	538	Murre	.1900	0.0000	0.0000	.0100
1802	113	538	Razorbill	.0200	0.0000	.0100	.0500
1802	113	539	Black Guillemot	0.0000	0.0000	0.0000	.0100
1802	113	540	Atlantic Puffin	0.0000	.0100	0.0000	.0200
1802	113	542	Other Phalaropes	.0100	.0300	.0100	.1000
1802	113	542	Red Phalarope	.1000	.0500	.0200	.0100
1802	113	542	Red-necked Phalarope	0.0000	.0800	.1200	.0600

APPENDIX R

ZONE 18 - PORTSMOUTH, NH (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Portsmouth Harbor		(Port 18)		Wildlife Abundance Tables Birds Numbers per Square Kilometer			
Port & Subzone	Species Category	Species Code	Species Name	Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
1802	113	547	Northern Gannet	.1900	.0100	.5400	.3400
1803	111	511	Duck	150.0000	0.0000	150.0000	300.0000
1803	111	513	Geese	75.0000	0.0000	75.0000	150.0000
1803	111	514	Swan	.5900	.5900	.5900	.5900
1803	112	599	Shore Birds	49.2000	297.9000	108.5000	6.9000
1804	111	511	Duck	150.0000	0.0000	150.0000	300.0000
1804	111	513	Geese	75.0000	0.0000	75.0000	150.0000
1804	111	514	Swan	.5900	.5900	.5900	.5900
1804	112	599	Shore Birds	49.2000	297.9000	108.5000	6.9000

APPENDIX S

PROVIDENCE, RI

(ZONE 19)

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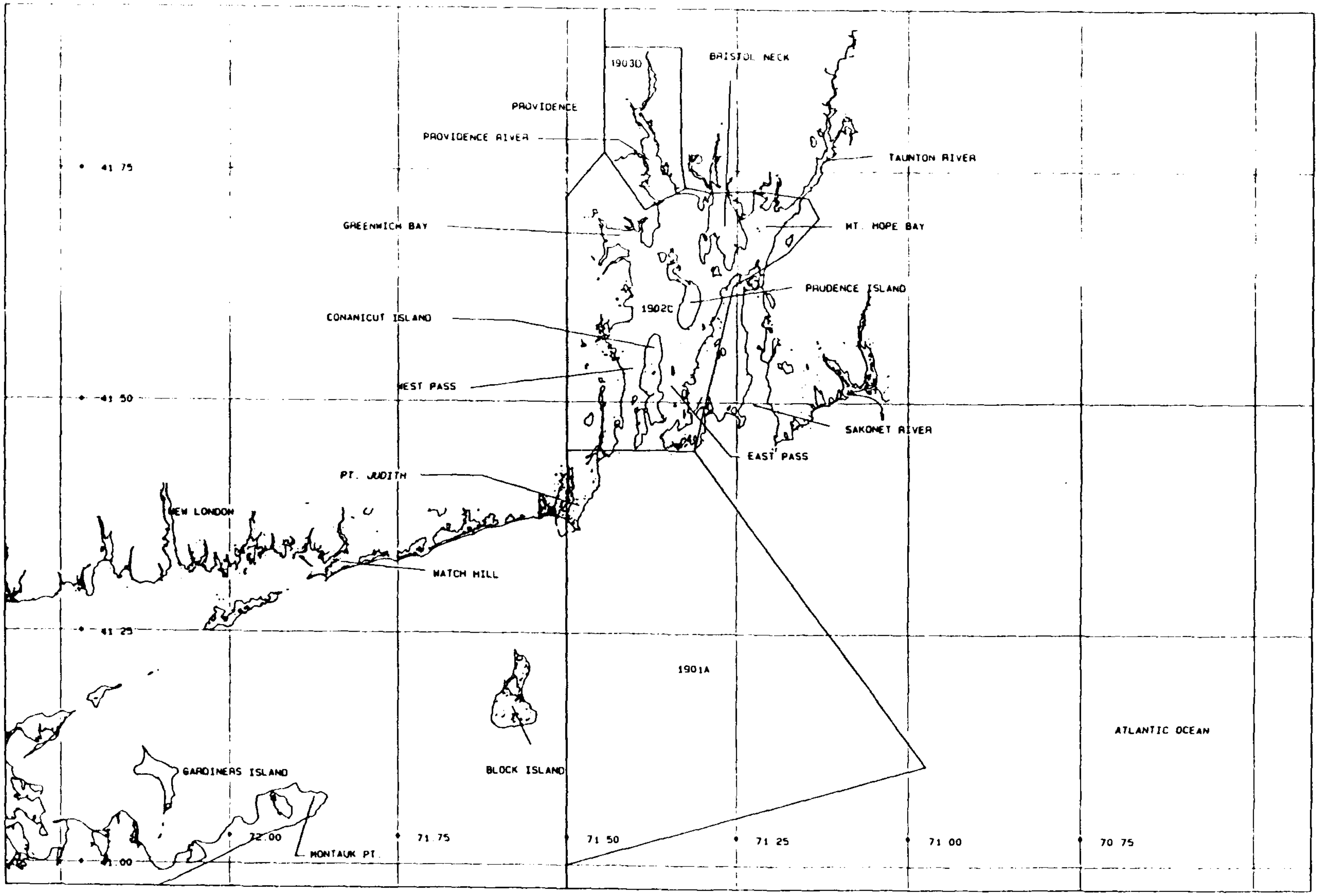
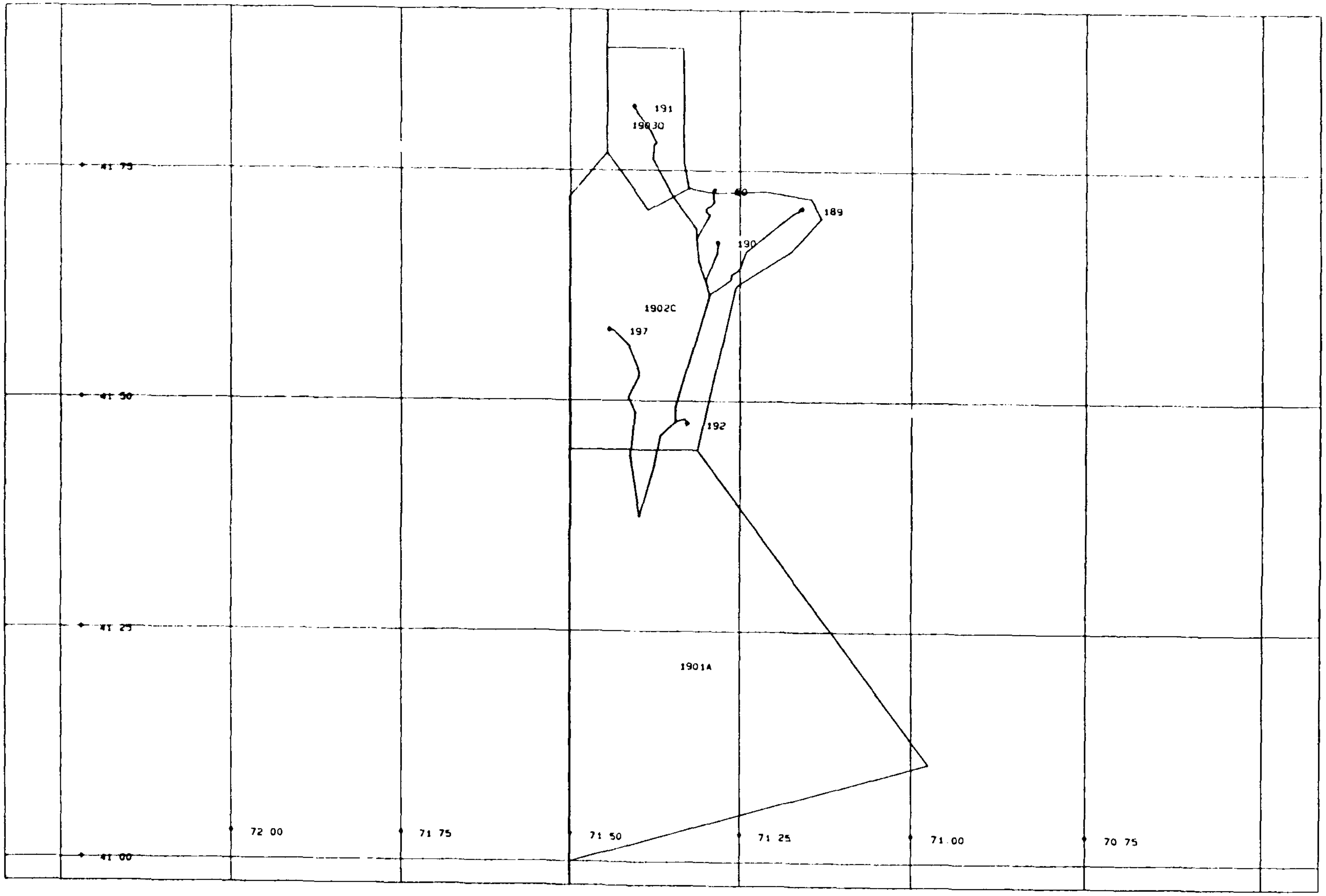
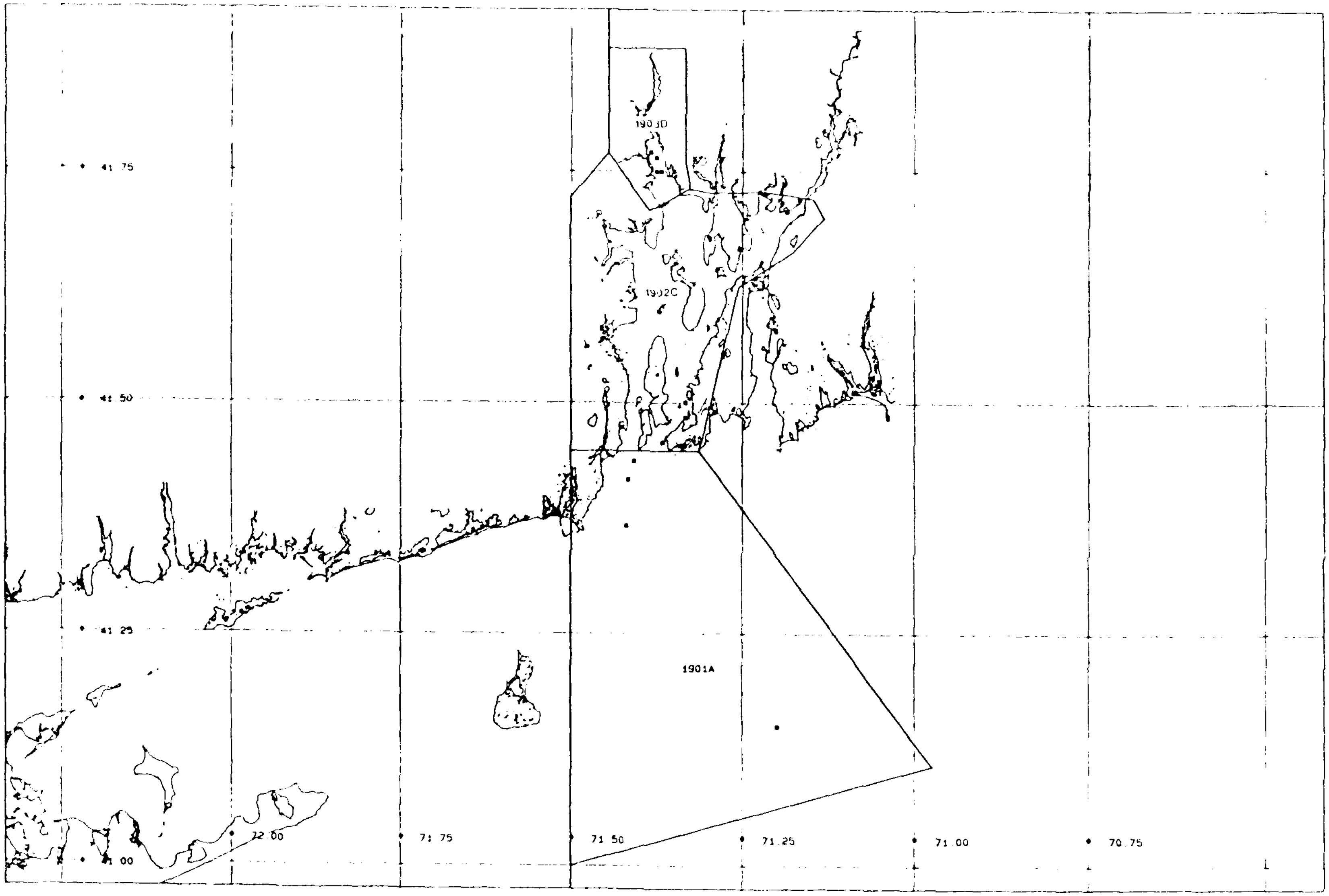
STUDY ZONE MAPS



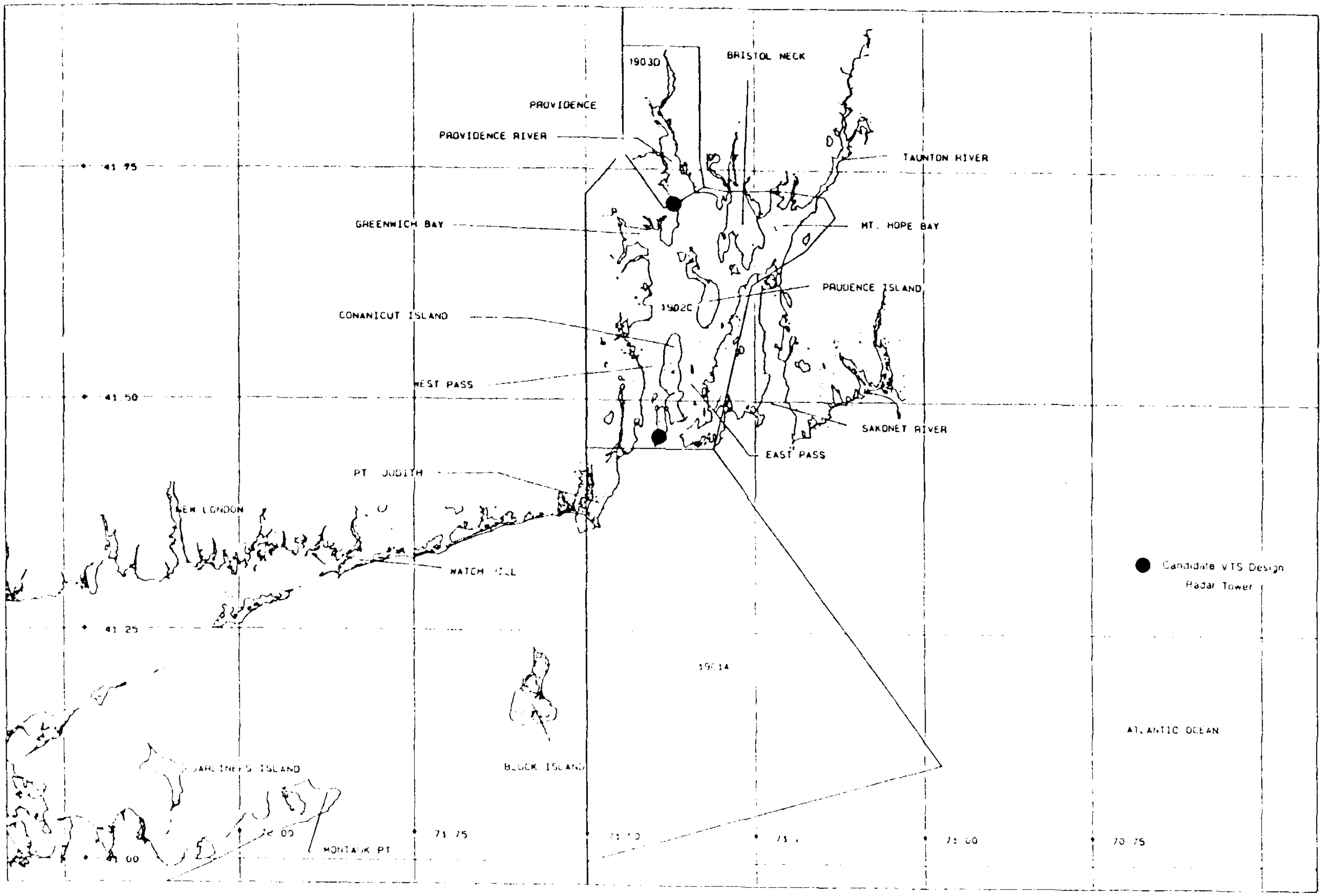
ZONE 19 - PROVIDENCE, RI - ZONE AND SUBZONE BOUNDARIES



ZONE 19 - PROVIDENCE, RI - DOMINANT VESSEL ROUTES AND COE WATERWAY CODES



ZONE 19 - PROVIDENCE, RI - BASE PERIOD (10 YEAR) VESSEL CASUALTIES



ZONE 19 - PROVIDENCE, RI - CANDIDATE VTS DESIGN RADAR LOCATIONS

CANDIDATE VTS DESIGN REPORT

FOR

PROVIDENCE, RI

(ZONE 19)

Prepared for:
U.S. Department of Transportation
Research and Special Programs Administration
John A. Volpe National Transportation Systems Center
Cambridge, MA 02142

Prepared by:
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7203 Gateway Court
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July 1991

OVERVIEW

The Candidate VTS Design described in this appendix is one of 23 developed for all the study zones included in the study. This appendix documents the task performed, under Contract DTRS-57-88-C-00088 Technical Task Directive 13, as an integral part of the total Port Needs Study. The ultimate product of this task effort is an informed preliminary technical assessment of the approximate cost to the Federal Government to implement and operate a state-of-the-art VTS system. This appendix does not contain a comprehensive definition of the VTS operating requirements nor does it propose a final VTS specification suitable for implementation.

In order to consistently estimate the life cycle costs of a VTS system in each of the study zones, a "Candidate VTS Design" has been defined for each study zone using a uniform set of design criteria. Each study zone Candidate VTS Design is a composite of generic modules selected from a master list of 18 state-of-the-art surveillance modules, communications and display technology. Among the surveillance modules in the master list are several levels of technical performance from which the selection is made for application to each study subzone to address the local navigational surveillance needs and conditions. The Candidate VTS Design in each study zone represents a consistent application of the surveillance modules at the subzone level. The subzone surveillance technology is subsequently integrated into a total system for the study zone via state-of-the-art communications and display consoles at the Vessel Traffic Center (VTC) in each zone.

The application of the surveillance modules in each subzone responds to the technical requirements of that subzone as perceived by the study team. The Candidate VTS Design represents a preliminary engineering judgement on the appropriate level of technology in each subzone. The Candidate VTS Design may be considered as an informed judgement made by the contractor study team for the sole purpose of developing cost estimates that are consistent across the 23 study zones and suitable for benefit/cost comparisons among the study zones and initial budget planning and implementation priorities. The approach used to calculate VTS system costs for all 23 study zones is found in Volume III, Technical Supplement.

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PORT OF PROVIDENCE, RHODE ISLAND VTS DESIGN

1.0 SCOPE

This report includes a port survey and a VTS design for Providence, Rhode Island. The port survey is based on a review of all pertinent literature including navigational charts. The methodology used to produce the VTS design entails coupling the problems identified in the port survey with solutions offered by state-of-the-art technology as identified in the VTS Technology Survey, November 1990. When possible, technological advances which permit manpower reductions are applied. Not all VTS problems are amenable to strictly technological solutions; some require changes in procedures and/or enforcement. These situations are identified where they occur.

2.0 PORT OF PROVIDENCE SURVEY

2.1 INTRODUCTION

This survey report is based exclusively upon review of available literature and examination of the charts for the area and its approaches. The information thus gained has been evaluated and interpreted based upon the Survey Team's experience as professional mariners and in vessel traffic management systems.

The Survey Area includes the Port of Providence, Rhode Island, Narragansett Bay and their approaches. Narragansett Bay forms one of the best natural harbors on the East Coast of the United States. The entrance from seaward appears simple but has proven dangerous to the unwary or careless. Within the Bay, the shipping lane which serves Providence is a combination of naturally deep water and confining improved channels.

Although traffic through Narragansett Bay and serving the Port of Providence is less than one-half that of Boston, the area has a long record of incidents. The most recent was in 1989 and resulted in a 300,000 gallon spill of fuel oil. Another spill, regardless of the level of ecological damage which might result, will have serious political and economic consequences. Proper vessel management, which includes navigational oversight and an ability to provide navigational assistance, should mitigate against repetition of past experience.

2.2 OVERVIEW OF THE PORT

Climate within the Survey Area is typical of southern coastal New England. The winters are sufficiently cold to form ice in the upper reaches of the Bay, and conditions are sometimes severe enough that icing causes outages to buoys. Fogs can be frequent between April and October. Providence averages 25 days per year

when visibility is less than 0.25 mile, but the figures for the entrance and southern Narragansett Bay are considerably higher.

The diurnal tidal range is 3.5 feet at the entrance and 4.6 feet at Providence. Tidal currents vary in strength throughout the area, from a maximum of about 0.5 knot at Brenton Reef Light to upward of 1.7 knots in the upper reaches of the Bay. Current induced sets can effect ship-handling and navigation.

Entrance to Narragansett Bay from seaward is through a Traffic Separation Scheme and naturally deep eastern entrance. Narragansett Bay itself is bordered by a number of small ports, including Newport, Rhode Island. The small ports, although subject to some barge traffic, are recreationally oriented rather than commercial. North of Newport, there is a U. S. Navy complex of some size. At Coddington Cove, facilities exist for homeporting several squadrons of destroyers/frigates and their associated tenders. There is a U.S. Navy Fuel Depot at Melville, as well as other facilities on the islands of the Bay and along its western shore.

A Federal project improves the Providence River to provide 40" from just south of Prudence Island Light to Fox Point (NOAA chart tabulations should be consulted for actual depths and widths). The entire passage from entrance to Providence is well marked by buoys and fixed aids to navigation. The sharply relieved shoreline and the presence of well-defined islands contributes to good radar navigation.

The West Passage into Narragansett Bay is infrequently used by commercial traffic and it was considered unnecessary to include it within the VTS design.

Pilotage is compulsory for all foreign-flag ships and U. S.-flag ships under register in the foreign trade. Pilot service is provided by several pilotage services: The Northeast Marine Pilots; the Associated Coast Pilots; and, the Interport Pilots, Inc. Pilots board vessels in the vicinity of Brenton Reef Light, about two to three miles southeastward of the structure. Pilot boats monitor VHF-FM channels 16 and 18A beginning at least one hour before the scheduled arrival of a ship and use CH18A as a working frequency.

2.3 EXISTING TRAFFIC MANAGEMENT

2.3.1 Traffic Separation Scheme (Narragansett Bay)

The Narragansett Bay Traffic Separation Scheme (TSS) has been established for the use of vessels entering and departing Narragansett Bay, but is not necessarily intended for use by tugs, tows or other small vessels with traditionally operate outside of the main shipping lanes. The TSS consists of <u>directed traffic lanes</u> with one-way traffic inbound and outbound traffic lanes

separated by a defined traffic separation zone and two precautionary areas, the northernmost of which is centered on Brenton Reef Light.

2.3.2 Narragansett Bay Approach Restricted Area

A two mile wide Restricted Area has been established from the northern limits of the TSS Separation Zone to 41^0-24.7'N. The Restricted Area is only closed to traffic during torpedo testing. When the Area is closed a white strobe light on Brenton Reef Light is activated and the area is patrolled by naval craft.

2.3.3 Recommended Bridge-to-Bridge Radiotelephone Procedures

The U. S. Coast Guard Captain of the Port (COTP) has developed a voluntary procedure of security calls designed to give notice of unseen vessels, intended movement and regulate VHF-FM Channel 13 traffic. The procedures, which supplement the Bridge-to-Bridge Radiotelephone Regulations (33CFR26), provide for the following security calls:

Inbound Traffic

When abeam of Brenton Reef Light.

When off Castle Hill Light.

At the south end of Prudence Island, reporting whether bound for Providence or Fall River.

Inbound for Providence, off Popasquash Neck and when approaching Bullock Point Light 26A.

Outbound Traffic

When leaving dock or anchorage.

Off Popasquash Neck.

Off Gould Island.

Outbound ships, hearing a call from an inbound ship off Castle Hill Light, are advised to pass East Passage Lighted Bell Buoy 11 close aboard since during ebbs they tend to be set toward the center of the channel.

Additional details of the voluntary calling are contained in the Coast Pilot (Reference 1).

2.3.4 Anchorages

A number of general, naval and explosives anchorages have been established in Narragansett Bay. The number reflects the general excellence of the shelter afforded by the Bay, and the widespread designation of naval anchorages underlines the importance of the Bay to the Atlantic Fleet. 33CFR110.145 should be consulted for details, including general anchorage regulations.

2.3.5 Prohibited Area

A Prohibited Area has been established in Narragansett Bay generally in the area between Conanicut and Prudence Islands. Within the Prohibited Area no vessel may at any time and under any circumstances anchor, fish or tow a drag of any kind. Refer to 33 CFR 334.80 for details.

2.4 VESSEL TRAFFIC

In 1987, the Port of Providence handled 7.5 million tons of cargo, 5.3 million tons of which were petroleum products (fuel oil, gasoline and jet fuel). There were 516 tanker movements and 913 tank barge movements (Reference 2). This compares with 1990 information indicating annual arrivals of 1100 vessels per year for the Narragansett Bay area, including Fall River. The 1100 arrivals are constituted as follows:

234 tank ships--170 oil, 64 other hazardous cargo, including 14 LPG carriers;
500 barges;
366 cargo or miscellaneous.

Naval movements to and from facilities in Coddington Cove are light and were not included.

The opening of the Jamestown-Newport Bridge brought an end to the Jamestown-Newport ferry, which removed the only real volume of traffic athwart the traffic flow between the sea and Providence.

There is considerable recreational boating during the May-September period, generally concentrated during major holidays and summer weekends. Scheduled regattas bring concentrations of boats between Goat Island and Fort Adams, and may also encroach upon the eastern entrance into Narragansett Bay. Periodically during summer there is substantial recreational traffic between Block Island and Narragansett Bay.

2.5 ENVIRONMENTAL SENSITIVITY

In June 1989 the tank ship PRODIGY, grounded off Brenton Reef and spilled 300,000 gallons of heating oil. Quick response and the light nature of the oil limited environmental damage but focused attention upon the vulnerability of the area to pollution damage. The shoreline around Narragansett Bay and its entrances is heavily populated, and the region draws upon tourism as a major source of income. The Bay is generally unpolluted, and most parts would be difficult to clean. The wetlands support large populations of aquatic birds but the waters may no longer support commercially important fisheries.

The PRODIGY spill probably contributed to Rhode Island's unlimited liability act and was most certainly responsible for the Congressional mandate to test Automatic Dependent Surveillance on Narragansett Bay shipping. The impact of the liability legislation may be to decrease the carriage of oil by vessel within Narragansett Bay, but this remains to be demonstrated. Subsequent major spills will have significant political fallout.

2.6 PORT SUB-ZONES

The Study Area was examined to determine appropriate sub-zones, using the methodology based upon the "confined-complex", "open-complex", "confined-simple" and "open-simple" system employed by the Canadian VTS Study in 1984 (Reference 3). Briefly stated, "open" and "confined" address the influence of geography upon a ship's ability to maneuver; and "simple" vs "complex" is descriptive of the nature of the interactions between ships within those geographic areas. This basic matrix was overlaid by a subjective assessment of appropriate traffic management/risk amelioration measures in order to derive sub-zones within which VTS needs are homogeneous, or nearly so.

2.6.1 Sub-Zone I -- Seaward Approaches (NOAA Chart 13218)

The sub-zone lies seaward of a line drawn from the shore south along 71^0-35'W to 41^0-10'N, thence east to 71^0-15'W, and then north to the shoreline.

The sub-zone functions essentially as a data catchment area for shipping entering Narragansett Bay from the sea. The principal function of the VTS within the sub-zone is to establish communications with inbound traffic and obtain information about characteristics, intentions and movements.

The sub-zone is "open-simple."

2.6.2 Sub-Zone II -- Narragansett Bay Entrance (NOAA Chart 13218)

The sub-zone lies between the inshore limits of Sub-Zone I (a line drawn from the shore south along 71^0-35'W to 41^0-10'N, thence east to 71^0-15'W, and then north to the shoreline) and a line between Brenton Point and the tower on Point Judith Neck.

The sub-zone contains the Inner Precautionary Area of the Narragansett Bay TSS, a number of navigational hazards to the NE and close-in approaches to Narragansett Bay itself. Navigational assistance and movement management advice is required.

The sub-zone is "confined-complex."

2.6.3 Sub-Zone III -- Narragansett Bay (NOAA Chart 13221)

The sub-zone lies between the inshore boundary of Sub-Zone II (a line between Brenton Point and the tower on Point Judith Neck) and an east-west line drawn tangent to the north end of Conanicut Island and extended to the mainland on the west and Rhode Island on the west.

The sub-zone contains numerous anchorages, bridge crossings and junctions of waterways around Conanicut Island, serving Newport and Jamestown. Navigational assistance and movement management advice is required.

The sub-zone is "confined-complex."

2.6.4 Sub-Zone IV -- Providence (NOAA Chart 13221 & 13224)

The sub-zone lies between Sub-Zone III (an east-west line drawn tangent to the north end of Conanicut Island and extended to the mainland on the west and Rhode Island on the west) and the head of Deep-Draft Navigation at Providence. It includes the Davisville and Quonset Point Channels. It is bounded to the east by the Mount Hope Bridge.

The sub-zone contains several Prohibited Areas, confined channels and navigational hazards. It also contains several channel junctions, among which is the channel leading to Mount Hope Bay and Fall River. Navigational assistance and movement management advice is required. Its upper reaches consist of Providence and the waterways serving that port's facilities.

The sub-zone is "confined-complex."

2.6.5 Sub-Zone V -- Mount Hope Bay (NOAA Chart 13221)

The sub-zone lies above the Mount Hope Bridge.

The sub-zone functions essentially as a data catchment area for shipping entering Narragansett Bay from Mount Hope Bay. The principal function of the VTS within the sub-zone is to establish communications with inbound traffic and obtain information about characteristics, intentions and movements.

The sub-zone is "confined-complex."

2.7 PROBLEM AREA IDENTIFIERS

2.7.1 PAI II-1. Precautionary Area

The Precautionary Area approach Narragansett Bay, especially to its eastern entrance, has historically been a trap for the unwary who take insufficient account of tidal currents. It is also a focal point on weekends and summer holidays for recreational boaters going to and from the offshore areas. The capability for providing navigational assistance is important during low visibility and bad weather and movement management advice may be required.

2.7.2 PAI III-1. Bull Point

The area between Bull Point, the Dumplings and Fort Adams is a turning point which, although it appears minor, can be unforgiving in poor visibility and/or with congestion. Movement management advice coupled with the ability to provide navigational assistance is required.

2.7.3 PAI III-2. Bishop Rock Shoal

In the vicinity of Bishop Rock shoal traffic tends to favor the eastern portion of the Bay to avoid the SE corner of the Prohibited Area. Movements of Navy ships departing Coddington Cove are sometimes difficult to detect. Movement management advice will reduce the potential for hazard here, as will the ability to provide navigational assistance if needed to properly shape for this point.

2.7.4 PAI IV-1. Prudence Island

The junction of the channels to Mount Hope Bay and Providence represents a point at which movement management advice will permit traffic flows to cross and merge smoothly and safely.

3.0 PROVIDENCE VTS DESIGN

3.1 INTRODUCTION

A detailed survey of the Port of Providence is the basis for this design. An approach to costing VTS systems is outlined in Vol. III, Technical Supplement and a method of categorizing surveillance sensors into "modules" has also been developed. These modules are defined in terms of cost and performance and are to be applied to all VTS designs in this study. The applicability of Automatic Dependent Surveillance (ADS) technology is also discussed in this report. The five sub-zones defined in the harbor survey remain the same.

Traffic management requirements for each sub-zone are developed from PAI analysis. Table 3-1 lists in tabular form a summation of the problems identified and the management required by sub-zone.

The hardware and software selected for this design provide the level of surveillance justified by the problems identified in each sub-zone. A secondary consideration is to locate all VTS assets so that they are sufficient for the sub-zone in question and can contribute to adjoining sub-zones to achieve maximum usage. All specific equipments are then selected based on perceived surveillance requirements and overall VTS system architecture.

3.1.1 VTS Design Approach

The choice of surveillance sensors is dependent on the VTS mission. For the purposes of this design, the VTS mission is defined as that which insures the safety of navigation and the protection of the environment. In order to accomplish this mission, mandatory participation of all vessels over 20 meters is essential. The Vessel Traffic Center (VTC) must provide navigation safety advice to all vessels. The VTS in the United States will have no facilitation of commerce role nor will it offer piloting assistance of any kind.

The primary criteria for selection of adequate surveillance sensors are:

- o Percentage of vessels of the desired minimum size detected in designated surveillance areas
- o Percentage of lost tracks
- o Accuracy of the position and track obtained
- o Reliability of the surveillance system

TABLE 3-1. PROVIDENCE, RI PROBLEM AREA IDENTIFIERS

PAI	LOCATION	PROBLEM	MANAGEMENT
I	Seaward Approaches	Data catchment area for inbound shipping.	Have knowledge of vessel movements, locations through reporting. Enter inbound shipping information into database.
II	Narragansett Bay Entrance	Navigational hazards, potential congestion.	Have real-time knowledge of vessel movements, locations. Provide navigational assistance and movement management advice.
III	Narragansett Bay	Potential congestion. Navigational hazards, bridge crossings and anchorages.	Same As Above.
IV	Providence	Potential congestion. Navigational hazards. Prohibited Areas, channel junctions.	Have real-time knowledge of vessel movements, locations. Provide navigational assistance and movement management advice.
V	Mt. Hope Bay	Data catchment area for inbound shipping.	Have knowledge of vessel movements and locations through reporting. Enter inbound shipping information into database.

- Timeliness of th^ ata obtained

- Ability to interpret and use the data obtained

Secondary criteria are:

- Cost of the VTS system -- reduction of manpower by the use of technology

- Expandability -- increased VTS responsibility, area, and/or support of other missions

Active surveillance sensors including radar, communications, and closed circuit television (CCTV) installations are used when detection and tracking of vessels is paramount to providing safety advice. These devices are considered fail safe in that it is known with certainty when they have failed. The performance characteristics of these sensors are known from operational VTS worldwide experience. In this design they are selected to assure that the necessary operational criteria identified for each sub-zone is realized.

Many dependent surveillance techniques are possible. These range from voice radio reporting of required VTS data to automatic position and identification recording devices that can be interrogated from shore known as Automatic Dependent Surveillance (ADS) devices. The position and/or movement reporting form of dependent surveillance is used extensively in existing VTS systems. The major regions of current use are those which do not require active surveillance. To apply ADS technology to a specific sub-zone within a VTS zone the following additional criteria must be considered:

- The number and class of vessels interacting in the sub-zone and which of these interactions are important to the VTS mission. Obviously all vessel classes of interest must be appropriately equipped. This requires that all vessels of the classes selected which will ever pass through this sub-zone must be equipped with an ADS device. This requirement to detect so many different vessels argues against the use of ADS. In areas where only one class of vessel is of interest, ADS is more easily implemented.

- The interactions or transits to be monitored must not demand that the surveillance be fail safe, i.e. positively detecting failures. This type of surveillance is related to position reporting in that it may not always function or be used properly and the VTS has limited control over its operation.

- It must be determined that if active surveillance is not justified, the additional information obtained from ADS over position reporting is necessary.

- If the class or group of vessels to be monitored is a "controllable" group, ADS can be easily implemented and satisfactory operation more readily achieved. Controllable means a clearly defined subset of vessels, e.g. a specific barge company; vessels carrying a specific cargo, etc.

- The number of different vessels in each class of interest that passes through the sub-zone in question must be determined. This number must be known to accurately estimate the cost of selecting this option for this sub-zone.

- A specific ADS solution for one sub-zone in one harbor may affect all the VTS designs for all the other sub-zones in all the other harbors.

3.1.2 Assumptions

The design of this VTS system starts with a set of assumptions based on the detailed survey and other data. These assumptions are as follows:

- As recommended by the IMO, all vessels of 20 meters or more in length are required to participate in the VTS. Participation is defined (at a minimum) as monitoring the VTS frequency and reporting as required.

- The VTS system is implemented with the cooperation and assistance of the port authorities, pilots associations, and marine exchange, if any. The existing facilities, services, and procedures established and operated by these organizations are major elements of an integrated VTS system as defined in the IMO VTS Guidelines.

- The life-cycle of all system hardware is ten years.

3.2 DESIGN DECISIONS (FIGURE 3-1)

3.2.1 General

Examination of the traffic levels, geographical features and identified problem areas in the port leads to the following selection and location of sensor hardware.

Surveillance Modules Sub Zones	RADAR						ADS			VHF		MET.		HYD.		DF	CCTV		COMMENTS
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
I																			Comms and partial Radar coverage from Sub-zone III
II																			Comms/Radar coverage from Sub-zone III
III	1									1	1	1							
IV	1									1			1						
V										1									

FIGURE 3-1. PROVIDENCE, RI SURVEILLANCE SURVEY

3.2.2 Hardware Location and Selection

3.2.2.1 Sub-Zone III

<u>Beavertail Point Site</u>	1 Module 1 radar 1 Module 10 VHF 1 Module 11 VHF 1 Module 12 MET
<u>Conimicut Point Site</u>	1 Module 1 radar 1 Module 10 VHF 1 Module 13 MET
<u>Fall River Site</u>	1 Module 10 VHF

3.2.3 Vessel Traffic Center

The design of the hardware and software should be modern and capable of operating with reduced staff levels and no loss of effectiveness. One watchstander with an integrated data workstation and decision aiding software can effectively manage the activity in this port. This Vessel Traffic Center concept demands that the watchstander be separated from any other harbor/port information requests. The Center must be structured so that such requests are controlled by a bulletin board type interface. One officer-in-charge and one clerk are also required for the proper administration of the facility.

The Vessel Traffic Center is located in Newport in a location with good visual surveillance of the channel. The center is to employ the following equipment:

3.2.3.1 VTS Console

This console provides total data integration from all sensors in all sectors. These data are graphically shown on raster scan, high light level, color displays. A data display is also provided. Console design architecture is general purpose computer based, open architecture, bus organized, allowing operation of the system as a local area network (LAN). Data interchange with other facilities by modem is provided as well as interface with the U.S. Coast Guard standard terminal. The design allows board level modification and expansion. Features of the software and hardware provided are:

- o Software written in a high level language.

- o Software providing the total integration of data from all VTS sensors.

- o Layering of data in at least four layers to be operator selectable.

- o The ability to sector data including sector to sector handoff of targets.

- o The ability to accept external digital data derived from transmissions of shipboard transponders or other sources and integrate the information with all other sensor data.

- o Automatic and/or manual acquisition of radar targets including automatic tracking and target ID assignments. Guard zones with automatic acquisition of all targets entering the zone.

- o Several warning levels of vessel interaction designed to direct attention to developing situations rather than a simple CPA alarm strategy.

- o Complete vessel monitoring and alarm capability including anchor watch, CPA, TCPA, track history, adjustable target velocity vectors, restricted area penetration and maneuvering monitor is provided. Additional warning and/or alarm features allowed by programming changes in high level language.

- o Complete modern color graphics capability with offset and zoom

- o Complete harbor navigation aid monitoring capability including buoy position, light status, etc.

- o Remote control of all radars and radar interfaces as well as radar data processing including site-to-site integration, clutter suppression, scan conversion and target extraction.

- o Complete track projection capability which can predict and/or analyze future interactions based on current position, destination and velocity.

- o The capability of constructing a complete vessel data base and interfacing it to the real-time data display from the VTS sensors.

3.2.3.2 Communications Console

This console is capable of remotely operating the proposed transmitting/receiving sites and allowing transmission and monitoring on all required frequencies. The console provides two operating positions each to be capable of complete communications control. It is capable of modular expansion if other remote communications sites are added.

3.2.3.3 Supervisor Control and Data Acquisition (SCADA) Equipment

A SCADA capability is provided to the major module level at remote sites so that the watchstander can determine the status of the entire VTS system. A graphic readout is provided in block diagram form indicating operational status of all elements in the system. Security monitoring of remote sites is also included.

3.2.3.4 Recording Equipment

Time synchronized video and audio recording equipment is to be provided. This equipment is capable of recording and playing back the data presented to the VTS watchstander and his reaction to the situation. An extra set of recording equipment is to be installed for redundancy purposes.

3.3 COST ESTIMATES

3.3.1 General

Vol. III, Technical Supplement discusses a generalized approach to estimating VTS system costs. This approach is based on interviews with system designers and purchasers of recently constructed systems. The cost of this VTS system has been estimated using this approach and is detailed below. The assumptions made in estimating these costs are listed in Paragraph 3.1.2.

3.3.2 Hardware (x $1000)

Vessel Traffic Center	non-recurring	recurring(10-yr)
VTS Console (1 workstation & all software)	500	
Communications console	100	
Recording Equipment	50	
SCADA Equipment (2 radar sites)	200	
Sub-total:	850	400

Sub-Zone I--Seaward Approaches (NOAA Chart 13218)

Comms coverage from facilities in Sub-Zone III.

Sub-Zone II--Narragansett Bay Entrance (NOAA Chart 13218)

Comms/radar coverage from Sub-Zone III.

Sub-Zone III--Narragansett Bay (NOAA Chart 13221)

1 Module 1 radar	310	310
1 Module 10 VHF	19	13
1 Module 11 VHF	48	20
1 Module 12 MET	20	5
Sub-total:	397	348

Sub-Zone IV--Providence (NOAA Charts 13221 & 13224)

1 Module 1 radar	310	310
1 Module 10 VHF	19	13
1 Module 13 MET	40	5
Sub-total:	369	328

Sub-Zone V--Mount Hope Bay (NOAA Chart 13221)

1 Module 10 VHF	19	13
Sub-total:	19	13
HARDWARE TOTALS:	1635	1089

3.3.3 Project Totals (x $1000)

Non-recurring

Hardware	$1635
Management, Engineering, etc. (50%) Assumptions: Turnkey system, Procurement by integ.contractor, good manufacturer support, some software provided, System Manual required	817
Installation site integration (20%) Assumptions: Complete installation by contractor, remote access no serious problem, many widespread sites	327
Spares & Training (10%)	164
Civil Engineering 1 remote radar site, a VTC in Newport, remote comms and WX sensors installations, land acquisition	1000
PROJECT ESTIMATE:	3943
Data Base Management System	300
TOTAL: (non-recurring)	$ 4243

Recurring (10 year)

Hardware	1089
1 Watchstander x 5 = 5 man/years @ 50K x 10	2500
1 Officer-in-Charge	500
1 Clerk	500
TOTAL: (recurring) (10-year life)	$ 4589
TOTAL 10-YEAR PROJECT COST:	$ 8832

REFERENCES

1. U.S. Coast Pilot, Atlantic Coast: Cape Cod to Sandy Hook, 24th Edition, 1989, NOAA, Washington, D.C., pp. 115-116.

2. Summary Statistics on Leading U.S. Ports, 1987, Center for Marine Conservation, 1990, Washington, D.C.

3. Final Report, National Vessel Traffic Services Study (TP5965E), Canadian Coast Guard, Ottawa 1984, pp. 89-91.

GLOSSARY

ADS: Automatic Dependent Surveillance

ARPA: Automatic Radar Plotting Aid.

"CONFINED-COMPLEX": a combination of terms relating to the geography and the nature of the interactions between ships. See Final Report National Vessel Traffic Services Study (TP-5965E), Canadian Coast Guard, Ottawa, October 1984, pp.89-91.

"CONFINED-SIMPLE": a combination terms relating to the geography and the nature of the interactions between ships. See Final Report National Vessel Traffic Services Study (TP-5965E), Canadian Coast Guard, Ottawa, October 1984, pp.89-91.

COTP: Captain of the Port

CCTV: closed circuit television

COLREGS LINE: a demarcation line delineating those waters upon which international regulations for the prevention of collisions at sea apply.

CPA: closest point of approach

DBMS: data base management system

DF: direction finder

FAA: Federal Aviation Administration

GIS: Geographic Information System

ICW: Intracoastal Waterway

IMO: International Maritime Organization

KW: Kilowatt

LAN: local area network

LLOYD'S LIST: a listing of all merchant vessels of the world including their physical characteristics. Published by Lloyd's of London.

LNG: liquified natural gas

NOAA: National Oceanic and Atmospheric Administration

"OPEN-COMPLEX": a combination of terms relating to the geography and the nature of the interactions between ships. See Final Report National Vessel Traffic Services Study (TP-5965E), Canadian Coast Guard, Ottawa, October 1984, pp. 89-91.

"OPEN-SIMPLE": a combination of terms relating to the geography and the nature of the interactions between ships. See Final Report National Vessel Traffic Services Study (TP-5965E), Canadian Coast Guard, Ottawa, October 1984, pp. 89-91.

PAI: Problem Area Identifier

PRECAUTIONARY AREA: an area normally an intersection, entrance to, or exit from a traffic separation scheme where vessel interactions are unpredictable

SCADA: Supervisor Control and Data Acquisition

TCPA: time of closest point of approach

TRAFFIC SEPARATION SCHEME: routes incorporating traffic separation to increase the safety of navigation, particularly in converging areas of high traffic density.

VHF: very high frequency

VTC: vessel traffic center

VTS: vessel traffic services

STUDY ZONE INPUT DATA AND OUTPUT STATISTICS

TABLE 1 Assignment of COE Waterway Codes to Subzones 8/06/91

COE Waterway		Name
Subzone 1901A		
50	A	WARREN RIVER, R. I.
189	A	FALL RIVER HARBOR, MASS.
190	A	BRISTOL HARBOR, R. I.
191	A	PROVIDENCE RIVER AND HARBOR, R. I.
192	A	NEWPORT HARBOR, R. I.
197	A	WICKFORD HARBOR, R. I.
Subzone 1902C		
50	A	WARREN RIVER, R. I.
189	A	FALL RIVER HARBOR, MASS.
190	A	BRISTOL HARBOR, R. I.
191	A	PROVIDENCE RIVER AND HARBOR, R. I.
192	A	NEWPORT HARBOR, R. I.
197	A	WICKFORD HARBOR, R. I.
Subzone 1903D		
191	A	PROVIDENCE RIVER AND HARBOR, R. I.

TABLE 2 Base Year 1987 Cargo Tons by Subzone, Commodity, and Vessel Type

Subzone 1901A

Comm. Code	Name	Dry Cargo	Tanker	Dry Cargo Barge Tow	Tanker Barge Tow	Total
1	FARM PRODUCTS	18	0	0	0	18
2	FOREST PRODUCTS	25,886	0	0	0	25,886
4	MINING PRODUCTS, NEC	2,822,516	0	0	0	2,822,516
5	PROC. FOODS & MFTRS, NEC	1,170,712	0	31,754	0	1,202,466
6	WASTE OF MANUFACTURING	450,150	0	0	0	450,150
2810	SODIUM HYDROXIDE (CAUSTI	14,163	0	0	0	14,163
2813	ALCOHOLS	0	9,391	0	7,401	16,792
2818	SULPHURIC ACID	6,000	0	0	0	6,000
2911	GASOLINE, INCL NATURAL	0	2,994,035	0	1,119,083	4,113,118
2912	JET FUEL	0	81,396	0	9,636	91,032
2913	KEROSENE	0	31,638	0	38,968	70,606
2914	DISTILLATE FUEL OIL	0	1,761,609	0	1,051,565	2,813,174
2915	RESIDUAL FUEL OIL	0	741,994	0	337,374	1,079,368
2916	LUBRIC OILS-GREASES	0	16,789	0	6,534	23,323
2917	NAPHTHA, PETRLM SOLVENTS	0	47,734	0	11,971	59,705
2921	LIQUI PETR-COAL-NATR GAS	0	109,988	0	27,582	137,570
	Subzone Total :	4,489,445	5,794,574	31,754	2,610,114	12,925,887

Subzone 1902C

Comm. Code	Name	Dry Cargo	Tanker	Dry Cargo Barge Tow	Tanker Barge Tow	Total
1	FARM PRODUCTS	18	0	0	0	18
2	FOREST PRODUCTS	25,886	0	0	0	25,886
4	MINING PRODUCTS, NEC	2,822,516	0	0	0	2,822,516
5	PROC. FOODS & MFTRS, NEC	1,170,712	0	31,754	0	1,202,466
6	WASTE OF MANUFACTURING	450,150	0	0	0	450,150
2810	SODIUM HYDROXIDE (CAUSTI	14,163	0	0	0	14,163
2813	ALCOHOLS	0	9,391	0	7,401	16,792
2818	SULPHURIC ACID	6,000	0	0	0	6,000
2911	GASOLINE, INCL NATURAL	0	2,994,035	0	1,119,083	4,113,118
2912	JET FUEL	0	81,396	0	9,636	91,032
2913	KEROSENE	0	31,638	0	38,968	70,606
2914	DISTILLATE FUEL OIL	0	1,761,609	0	1,051,565	2,813,174
2915	RESIDUAL FUEL OIL	0	741,994	0	337,374	1,079,368
2916	LUBRIC OILS-GREASES	0	16,789	0	6,534	23,323
2917	NAPHTHA, PETRLM SOLVENTS	0	47,734	0	11,971	59,705
2921	LIQUI PETR-COAL-NATR GAS	0	109,988	0	27,582	137,570
	Subzone Total :	4,489,445	5,794,574	31,754	2,610,114	12,925,887

TABLE 2 Base Year 1987 Cargo Tons by Subzone, Commodity, and Vessel Type

Subzone 19030

Comm. Code	Name	Dry Cargo	Tanker	Dry Cargo Barge Tow	Tanker Barge Tow	Total
1	FARM PRODUCTS	18	0	0	0	18
2	FOREST PRODUCTS	8,788	0	0	0	8,788
4	MINING PRODUCTS, NEC	193,788	0	0	0	193,788
5	PROC. FOODS & MFTRS, NEC	1,039,996	0	31,754	0	1,071,750
6	WASTE OF MANUFACTURING	450,150	0	0	0	450,150
2810	SODIUM HYDROXIDE (CAUSTI	11,658	0	0	0	11,658
2911	GASOLINE, INCL NATURAL	0	2,287,334	0	582,273	2,869,607
2912	JET FUEL	0	49,236	0	9,250	58,486
2913	KEROSENE	0	22,994	0	27,465	50,459
2914	DISTILLATE FUEL OIL	0	1,349,017	0	651,281	2,000,298
2915	RESIDUAL FUEL OIL	0	409,997	0	112,780	522,777
2916	LUBRIC OILS-GREASES	0	12,463	0	3,125	15,588
2917	NAPHTHA, PETRLM SOLVENTS	0	47,734	0	11,971	59,705
2921	LIQUI PETR-COAL-NATR GAS	0	109,988	0	27,582	137,570
	Subzone Total :	1,704,398	4,288,763	31,754	1,425,727	7,450,642

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Appendix S ZONE 19 Providence, RI

TABLE 3 Base Year (1987)
Vessel Transits by Subzone, Vessel Type, and Size.

Vessel Type	Large	Medium	Small	Total
Subzone : 1901A				
Passenger	0	52	791	843
Dry Cargo	117	329	1,125	1,571
Tanker	81	250	359	690
Dry Cargo Barge Tow	14	0	170	184
Tanker Barge Tow	343	0	1,016	1,359
Tug/Tow Boat	0	0	2,220	2,220
Subzone Total:	555	631	5,681	6,867
Subzone : 1902C				
Passenger	0	52	12,645	12,697
Dry Cargo	117	329	1,125	1,571
Tanker	81	250	359	690
Dry Cargo Barge Tow	14	0	170	184
Tanker Barge Tow	343	0	1,016	1,359
Tug/Tow Boat	0	0	2,220	2,220
Subzone Total:	555	631	17,535	18,721
Subzone : 1903D				
Passenger	0	2	144	146
Dry Cargo	58	209	67	334
Tanker	71	150	295	516
Dry Cargo Barge Tow	1	0	157	158
Tanker Barge Tow	218	0	695	913
Tug/Tow Boat	0	0	959	959
Subzone Total:	348	361	2,317	3,026

Note: Sum of all vessel transits within each study subzone.

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Appendix S ZONE 19 Providence, RI

TABLE 3 Base Year (1987)
Vessel Transits by Suzone, Vessel Type, Size.

ZONE TOTALS

ZONE 19 Providence, RI

Vessel Type	Large	Medium	Small	Total
Passenger	0	52	12,645	12,697
Dry Cargo	117	329	1,125	1,571
Tanker	81	250	359	690
Dry Cargo Barge Tow	14	0	170	184
Tanker Barge Tow	343	0	1,016	1,359
Tug/Tow Boat	0	0	2,220	2,220
Zone Total:	555	631	17,535	18,721

Note: Sum of all arrivals/departures to/from all terminals within the Study Zone.

Appendix S Zone 19 Providence, RI

TABLE 4 Barges Per Tow - Average Factors by COE Waterway 8/6/91

COE Code	Waterway Name	Dry Barge	Tank Barge
SUBZONE	All Subzones within this Zone	1	1

NOTE: Average size of tows arriving/departing terminals within the waterway. Sizes of other tows transiting the area may differ.

Appendix S Zone 19 Providence, RI

TABLE 5 Other Local Vessels by Subzone 7/21/91

Subzone	Name	Number of Vessels	Vessels per Square Mile
1901A		1,405	2.68
1902C		9,835	89.41
1903D		11,240	1,262.92
	Total for Zone	22,480	34.91

Note: State registered (1989/90) vessels estimated to be operated within the Subzone.

Appendix S ZONE 19 Providence, RI

7/24/91

TABLE 6.1 Forecast 1995
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 1901A				
Passenger	0	53	807	860
Dry Cargo	154	437	1,317	1,908
Tanker	86	268	381	735
Dry Cargo Tow	0	0	186	186
Tanker Tow	303	0	1,121	1,424
Tug/Tow Boat	0	0	2,078	2,078
Subzone Total:	543	758	5,890	7,191
Subzone : 1902C				
Passenger	0	53	12,894	12,947
Dry Cargo	154	437	1,317	1,908
Tanker	86	268	381	735
Dry Cargo Tow	0	0	186	186
Tanker Tow	303	0	1,121	1,424
Tug/Tow Boat	0	0	2,078	2,078
Subzone Total:	543	758	17,977	19,278
Subzone : 1903D				
Passenger	0	2	147	149
Dry Cargo	84	306	92	482
Tanker	75	163	311	549
Dry Cargo Tow	0	0	172	172
Tanker Tow	193	0	764	957
Tug/Tow Boat	0	0	1,122	1,122
Subzone Total:	352	471	2,608	3,431

Note: Sum of all vessel transits within each study subzone.

7/24/91

Appendix S ZONE 19 Providence, RI

TABLE 6.2 Forecast 2000
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 1901A				
Passenger	0	54	822	876
Dry Cargo	186	535	1,456	2,177
Tanker	91	284	401	776
Dry Cargo Tow	0	0	195	195
Tanker Tow	321	0	1,198	1,519
Tug/Tow Boat	0	0	2,392	2,392
Subzone Total:	598	873	6,464	7,935
Subzone : 1902C				
Passenger	0	54	13,147	13,201
Dry Cargo	186	535	1,456	2,177
Tanker	91	284	401	776
Dry Cargo Tow	0	0	195	195
Tanker Tow	321	0	1,198	1,519
Tug/Tow Boat	0	0	2,392	2,392
Subzone Total:	598	873	18,789	20,260
Subzone : 1903D				
Passenger	0	2	150	152
Dry Cargo	108	397	114	619
Tanker	79	174	326	579
Dry Cargo Tow	0	0	181	181
Tanker Tow	203	0	816	1,019
Tug/Tow Boat	0	0	1,352	1,352
Subzone Total:	390	573	2,939	3,902

Note: Sum of all vessel transits within each study subzone.

Appendix S ZONE 19 Providence, RI

TABLE 6.3 Forecast 2005
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 1901A				
Passenger	0	55	842	897
Dry Cargo	229	673	1,618	2,520
Tanker	95	300	423	818
Dry Cargo Tow	0	0	205	205
Tanker Tow	337	0	1,281	1,618
Tug/Tow Boat	0	0	2,798	2,798
Subzone Total:	661	1,028	7,167	8,856
Subzone : 1902C				
Passenger	0	55	13,459	13,514
Dry Cargo	229	673	1,618	2,520
Tanker	95	300	423	818
Dry Cargo Tow	0	0	205	205
Tanker Tow	337	0	1,281	1,618
Tug/Tow Boat	0	0	2,798	2,798
Subzone Total:	661	1,028	19,784	21,473
Subzone : 1903D				
Passenger	0	2	153	155
Dry Cargo	142	527	145	814
Tanker	83	184	342	609
Dry Cargo Tow	0	0	191	191
Tanker Tow	212	0	871	1,083
Tug/Tow Boat	0	0	1,667	1,667
Subzone Total:	437	713	3,369	4,519

Note: Sum of all vessel transits within each study subzone.

Appendix S ZONE 19 Providence, RI

TABLE 6.4 Forecast 2010
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 1901A				
Passenger	0	57	862	919
Dry Cargo	288	864	1,806	2,958
Tanker	101	318	446	865
Dry Cargo Tow	0	0	217	217
Tanker Tow	356	0	1,367	1,723
Tug/Tow Boat	0	0	3,336	3,336
Subzone Total:	745	1,239	8,034	10,018
Subzone : 1902C				
Passenger	0	57	13,778	13,835
Dry Cargo	288	864	1,806	2,958
Tanker	101	318	446	865
Dry Cargo Tow	0	0	217	217
Tanker Tow	356	0	1,367	1,723
Tug/Tow Boat	0	0	3,336	3,336
Subzone Total:	745	1,239	20,950	22,934
Subzone : 1903D				
Passenger	0	2	157	159
Dry Cargo	191	711	188	1,090
Tanker	88	196	360	644
Dry Cargo Tow	0	0	202	202
Tanker Tow	222	0	929	1,151
Tug/Tow Boat	0	0	2,105	2,105
Subzone Total:	501	909	3,941	5,351

Note: Sum of all vessel transits within each study subzone.

Appendix S ZONE 19 Providence, RI

TABLE 6.5 Forecast 1995 - 2010 Vessel Transits by Vessel Type and Size

Vessel Type	Large	Medium	Small	Total
	1995 FORECASTED ZONE TOTALS			
Passenger	0	53	12,894	12,947
Dry Cargo	148	413	1,250	1,811
Tanker	86	268	381	735
Dry Cargo Tow	0	0	186	186
Tanker Tow	303	0	1,121	1,424
Tug/Tow Boat	0	0	2,078	2,078
1995 Zone Total:	537	734	17,910	19,181
	2000 FORECASTED ZONE TOTALS			
Passenger	0	54	13,147	13,201
Dry Cargo	174	486	1,341	2,001
Tanker	91	284	401	776
Dry Cargo Tow	0	0	195	195
Tanker Tow	321	0	1,198	1,519
Tug/Tow Boat	0	0	2,392	2,392
2000 Zone Total:	586	824	18,674	20,084
	2005 FORECASTED ZONE TOTALS			
Passenger	0	55	13,459	13,514
Dry Cargo	214	597	1,469	2,280
Tanker	95	300	423	818
Dry Cargo Tow	0	0	205	205
Tanker Tow	337	0	1,281	1,618
Tug/Tow Boat	0	0	2,798	2,798
2005 Zone Total:	646	952	19,635	21,233
	2010 FORECASTED ZONE TOTALS			
Passenger	0	57	13,778	13,835
Dry Cargo	268	764	1,641	2,673
Tanker	101	318	446	865
Dry Cargo Tow	0	0	217	217
Tanker Tow	356	0	1,367	1,723
Tug/Tow Boat	0	0	3,336	3,336
2010 Zone Total:	725	1,139	20,785	22,649

Note: Sum of all arrivals/departures to/from all terminals within the study zone.

TABLE 7 Vessel Casualty History (10 Year Totals) by Subzone, Vessel Type and Size, and Casualty Type

Vessel Type	Size	Collisions	Rammings	Groundings	Other	Total
Subzone: 1901A						
Passenger	Small	1	0	0	0	1
Dry Cargo	Medium	1	0	0	0	1
Tanker	Large	0	0	1	0	1
Tanker Barge Tow	Small	1	0	0	0	1
Fishing	Small	2	0	0	0	2
Other	Small	1	0	0	0	1
Subzone Totals:		6	0	1	0	7
Subzone: 1902C						
Passenger	Medium	1	0	0	0	1
Dry Cargo	Large	0	0	1	0	1
Tanker	Large	0	1	0	0	1
Tanker Barge Tow	Small	0	2	0	0	2
Tug/Tow Boat	Small	0	1	0	0	1
Other	Small	1	0	0	0	1
Subzone Totals:		2	4	1	0	7
Subzone: 1903D						
Tanker	Large	0	0	1	0	1
Dry Cargo Barge Tow	Small	0	0	1	0	1
Tanker Barge Tow	Small	0	0	3	0	3
Fishing	Small	0	0	1	0	1
Subzone Totals:		0	0	6	0	6
Zone Totals:		8	4	8	0	20

Note: OTHER equals barge breakaways and weather caused vessel casualties.

APPENDIX TABLE S-8 ZONE 19, PROVIDENCE, RI - VTS LEVELS IN OPERATION

(Not Applicable to This Sub-Zone.)

APPENDIX TABLE S-9 ZONE 19, PROVIDENCE, RI
CANDIDATE VTS DESIGN - 1995-2010

UNITS

2	Radar Module 1	- Average Performance
0	Radar Module 2	- Average Performance
0	Radar Module 3	- High Performance
0	Radar Module 4	- High Performance
0	Radar Module 5	- Special Purpose
0	Radar Module 6	- Special Purpose
0	ADS Module 7	- Active Radar Transponder (Type 1)
0	ADS Module 8	- Positional Transponder, Small Area, Very High Accuracy (Type 5)
0	ADS Module 9	- Positional Transponder, Small Area, High Accuracy (Type 6)
3	VHF Module 10	- Low power VHF Transmitting/ Receiving Facility
1	VHF Module 11	- High power VHF Transmitting/ Receiving Facility
1	Meteorological Module 12	- Air temperature, wind direction and speed
1	Meteorological Module 13	- Air temperature, wind direction and speed, visibility
0	Hydrological Module 14	- Water Temperature and Depth
0	Hydrological Module 15	- Water Temperature, Depth and Current
0	VHF/DF MODULE 16	- Line of position measurement to 2 degree RMS
0	CCTV MODULE 17	- Fixed Focus CCTV via Telephone Lines
0	CCTV MODULE 18	- Remotely Controllable CCTV via

TABLE 10A Avoided Vessel Casualties 1996 - 2010 7/31/91
Candidate VTS Systems

Counts

Vessel Type	Size	Collision	Ramming	Grounding	Total
Passenger	Medium	.12	0.00	.19	.30
Passenger	Small	.34	.06	.51	.91
Dry Cargo	Large	.22	.04	.37	.64
Dry Cargo	Medium	.26	.05	.14	.45
Dry Cargo	Small	.15	.02	.04	.21
Tanker	Large	.23	.06	.41	.70
Tanker	Medium	.08	.01	.07	.16
Tanker	Small	.05	0.00	.05	.10
Dry Cargo Barge T	Small	.12	.04	.06	.22
Tanker Barge Tow	Large	.22	.12	.19	.53
Tanker Barge Tow	Small	.77	.15	.70	1.62
Tug/Tow Boat	Small	.18	.07	.19	.43
		2.75	.61	2.93	6.29

Undiscounted Total Dollar Losses (1,000)

Vessel Type	Size	Collision	Ramming	Grounding	Total
Passenger	Medium	218	0	222	440
Passenger	Small	303	52	320	676
Dry Cargo	Large	327	81	120	527
Dry Cargo	Medium	418	95	43	555
Dry Cargo	Small	104	13	24	142
Tanker	Large	1,255	319	1,111	2,686
Tanker	Medium	159	18	38	215
Tanker	Small	44	0	15	59
Dry Cargo Barge T	Small	7	5	1	12
Tanker Barge Tow	Large	1,771	891	920	3,582
Tanker Barge Tow	Small	2,511	491	387	3,389
Tug/Tow Boat	Small	13	8	13	35
		7,130	1,973	3,215	12,319

Note: In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 11 Avoided Fatalities 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Medium	.01	0.00	.02	.04
Passenger	Small	.02	.00	.03	.06
Dry Cargo	Large	.03	.01	.05	.08
Dry Cargo	Medium	.03	.01	.02	.06
Dry Cargo	Small	.01	.00	.00	.01
Tanker	Small	.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	.00	.00	.00	.00
Tanker Barge Tow	Small	.00	.00	.00	.00
Tug/Tow Boat	Small	.00	.00	.00	.00
Totals		.11	.02	.13	.25
Candidate VTS Design - Dollars					
Passenger	Medium	21,977.03	0.00	35,328.57	57,305.61
Passenger	Small	33,010.08	5,705.20	49,128.01	87,843.29
Dry Cargo	Large	42,114.15	8,071.07	70,359.99	120,545.21
Dry Cargo	Medium	49,753.85	8,930.79	26,138.75	84,823.39
Dry Cargo	Small	14,490.75	1,897.20	3,774.92	20,162.87
Tanker	Small	168.41	0.00	175.28	343.69
Dry Cargo Barge Tow	Small	395.43	131.44	207.10	733.97
Tanker Barge Tow	Small	2,548.92	494.50	2,315.92	5,359.35
Tug/Tow Boat	Small	579.73	225.77	628.54	1,434.04
Totals		165,038.35	25,455.97	188,057.09	378,551.41

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 12 Avoided Human Injuries 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Medium	.00	0.00	.00	.00
Passenger	Small	.26	.05	.39	.69
Dry Cargo	Large	.00	.00	.01	.01
Dry Cargo	Medium	.00	.00	.00	.01
Dry Cargo	Small	.11	.01	.03	.16
Tanker	Small	.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	.00	.00	.00	.01
Tanker Barge Tow	Small	.02	.00	.02	.04
Tug/Tow Boat	Small	.00	.00	.00	.01
Totals		.41	.07	.45	.93
Candidate VTS Design - Dollars					
Passenger	Medium	377.34	0.00	606.58	983.92
Passenger	Small	62,158.53	10,742.99	92,508.86	165,410.38
Dry Cargo	Large	723.09	138.58	1,208.06	2,069.73
Dry Cargo	Medium	854.26	153.34	448.80	1,456.40
Dry Cargo	Small	27,286.32	3,572.45	7,108.24	37,967.02
Tanker	Small	294.27	0.00	306.27	600.54
Dry Cargo Barge Tow	Small	690.94	229.66	361.88	1,282.47
Tanker Barge Tow	Small	4,453.77	864.05	4,046.64	9,364.46
Tug/Tow Boat	Small	1,012.97	394.49	1,098.25	2,505.72
Totals		97,851.49	16,095.56	107,693.58	221,640.64

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 13 Avoided Vessels Damaged 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Medium	.09	0.00	.08	.17
Passenger	Small	.29	.04	.16	.49
Dry Cargo	Large	.17	.03	.04	.23
Dry Cargo	Medium	.20	.03	.01	.24
Dry Cargo	Small	.13	.01	.02	.16
Tanker	Large	.17	.05	.05	.27
Tanker	Medium	.06	.01	.01	.08
Tanker	Small	.01	0.00	.01	.02
Dry Cargo Barge Tow	Small	.09	.02	.01	.12
Tanker Barge Tow	Large	.20	.06	.04	.30
Tanker Barge Tow	Small	.59	.06	.10	.75
Tug/Tow Boat	Small	.03	.01	.02	.06
Totals		2.03	.32	.55	2.90
Candidate VTS Design - Dollars					
Passenger	Medium	75,606.56	0.00	70,570.63	146,177.19
Passenger	Small	99,868.05	13,490.98	82,355.30	195,714.33
Dry Cargo	Large	122,407.23	22,450.22	21,667.31	166,524.76
Dry Cargo	Medium	174,706.99	30,011.25	6,018.13	210,736.38
Dry Cargo	Small	24,550.11	2,613.59	5,286.74	32,450.44
Tanker	Large	135,384.95	36,856.27	115,898.43	288,139.65
Tanker	Medium	40,675.54	4,562.27	15,777.38	61,015.18
Tanker	Small	3,337.58	0.00	4,531.06	7,868.64
Dry Cargo Barge Tow	Small	5,299.75	975.42	443.18	6,718.35
Tanker Barge Tow	Large	32,595.70	9,448.90	7,707.75	49,752.36
Tanker Barge Tow	Small	41,736.16	4,483.50	8,804.49	55,024.14
Tug/Tow Boat	Small	2,211.99	553.29	2,331.98	5,097.27
Totals		758,380.62	125,445.68	341,392.37	1,225,218.68

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 14 Avoided Cargo Damage/Loss 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Medium	.02	0.00	.01	.04
Passenger	Small	.07	.01	.04	.13
Dry Cargo	Large	.06	.01	.03	.11
Dry Cargo	Medium	.07	.02	.01	.10
Dry Cargo	Small	.05	.01	.01	.06
Tanker	Large	.06	.02	.04	.12
Tanker	Medium	.02	.00	.01	.03
Tanker	Small	.01	0.00	.01	.02
Dry Cargo Tow	Small	.02	.01	.00	.03
Tanker Tow	Large	.02	.01	.01	.04
Tanker Tow	Small	.11	.02	.04	.17
Tug/Tow Boat	Small	.01	.00	.01	.02
Totals		.52	.11	.23	.86
Candidate VTS Design - Dollars					
Passenger	Medium	332.61	0.00	219.64	552.26
Passenger	Small	252.56	34.12	185.99	472.66
Dry Cargo	Large	630.22	171.12	99.57	900.90
Dry Cargo	Medium	744.54	189.34	36.99	970.88
Dry Cargo	Small	111.42	11.86	23.73	147.01
Tanker	Large	4,375.46	1,133.76	6,533.52	12,042.74
Tanker	Medium	325.53	35.91	96.16	457.60
Tanker	Small	49.22	0.00	30.32	79.54
Tanker Tow	Large	8,147.60	4,297.03	6,835.72	19,280.35
Tanker Tow	Small	11,247.56	2,181.10	4,157.23	17,585.89
Tug/Tow Boat	Small	26.63	6.66	27.32	60.61
Totals		26,243.34	8,060.89	18,246.20	52,550.43

Note1: Dollar values include bulk petroleum and chemical cargos only and all vessel fuels spilled. Dollar values exclude cargo loss/damage [illegible] vessel types.

Note2: In Counts, 0.00 equals 0.0000000; .00 represents a number less than [illegible] and greater than 0.0000000 rounded to two decimal places. Counts [illegible] calculated before rounding.

TABLE 15 Avoided NavAid Damage 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Small	0.00	.01	.00	.01
Dry Cargo	Large	0.00	.00	.00	.01
Dry Cargo	Medium	0.00	.01	.00	.01
Dry Cargo	Small	0.00	.00	.00	.00
Tanker	Large	0.00	.01	.00	.01
Tanker	Medium	0.00	.00	.00	.00
Tanker	Small	0.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	0.00	.00	.00	.00
Tanker Barge Tow	Large	0.00	.01	.00	.01
Tanker Barge Tow	Small	0.00	.02	.00	.02
Tug/Tow Boat	Small	0.00	.01	.00	.01
Totals		0.00	.07	.02	.09
Candidate VTS Design - Dollars					
Passenger	Small	0.00	38.36	16.53	54.89
Dry Cargo	Large	0.00	27.70	12.09	39.79
Dry Cargo	Medium	0.00	30.65	4.49	35.14
Dry Cargo	Small	0.00	12.75	1.27	14.03
Tanker	Large	0.00	37.84	13.26	51.10
Tanker	Medium	0.00	5.56	2.16	7.73
Tanker	Small	0.00	0.00	1.71	1.71
Dry Cargo Barge Tow	Small	0.00	25.67	2.02	27.69
Tanker Barge Tow	Large	0.00	74.87	6.24	81.12
Tanker Barge Tow	Small	0.00	96.57	22.64	119.21
Tug/Tow Boat	Small	0.00	44.09	6.14	50.23
Totals		0.00	394.06	88.58	482.64

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 16 Avoided Bridge Damage 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Small	.00	.00	0.00	.00
Dry Cargo	Large	0.00	.00	0.00	.00
Dry Cargo	Medium	0.00	.00	0.00	.00
Dry Cargo	Small	.00	.00	0.00	.00
Tanker	Large	0.00	.00	0.00	.00
Tanker	Medium	0.00	.00	0.00	.00
Tanker	Small	.00	0.00	0.00	.00
Dry Cargo Barge Tow	Small	.00	.00	0.00	.00
Tanker Barge Tow	Large	0.00	.01	0.00	.01
Tanker Barge Tow	Small	.00	.01	0.00	.01
Tug/Tow Boat	Small	.00	.00	0.00	.00
Totals		.00	.03	0.00	.04
Candidate VTS Design - Dollars					
Passenger	Small	910.58	7,075.77	0.00	7,986.35
Dry Cargo	Large	0.00	6,277.44	0.00	6,277.44
Dry Cargo	Medium	0.00	7,138.38	0.00	7,138.38
Dry Cargo	Small	238.45	1,396.83	0.00	1,635.28
Tanker	Large	0.00	8,952.30	0.00	8,952.30
Tanker	Medium	0.00	1,266.18	0.00	1,266.18
Tanker	Small	95.38	0.00	0.00	95.38
Dry Cargo Barge Tow	Small	228.12	3,322.46	0.00	3,550.58
Tanker Barge Tow	Large	0.00	17,089.94	0.00	17,089.94
Tanker Barge Tow	Small	1,411.76	12,035.78	0.00	13,447.54
Tug/Tow Boat	Small	278.32	4,838.38	0.00	5,116.70
Totals		3,162.60	69,393.46	0.00	72,556.07

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

Appendix S   Zone 19 Providence, RI
TABLE 17 Avoided Hazardous Commodity Spills 1996 - 2010   7/30/91

Commodity	Catastrophic	Large	Medium	Small	Total
Candidate Vts Design - Counts					
ALCOHOLS	.00	.00	.00	.00	.00
JET FUEL	.00	.00	.00	.00	.00
KEROSENE	.00	.00	.00	.00	.01
RESIDUAL FUEL OIL	.00	.01	.08	.18	.27
DISTILLATE FUEL OIL	.01	.04	.09	.17	.31
GASOLINE, INCL NATURAL	.01	.02	.02	.00	.06
	.02	.07	.20	.36	.65

Note: In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

Appendix S Zone 19 Providence, RI
TABLE 18A Annual Benefit & Cost Streams 7/31/91
Candidate VTS Systems

Discounted to 1993

Year	Investment ($1,000)	Operation & Maintenance ($1,000)	Benefits ($1,000)
1993	4,243	0	0
1996	0	361	587
1997	0	328	541
1998	0	299	498
1999	0	271	459
2000	0	247	423
2001	0	224	389
2002	0	204	359
2003	0	185	330
2004	0	169	304
2005	0	153	281
2006	0	139	259
2007	0	127	239
2008	0	115	220
2009	0	105	203
2010	0	95	188
	4,243	3,022	5,281

Undiscounted

Year	Investment ($1,000)	Operation & Maintenance ($1,000)	Benefits ($1,000)
1993	4,243	0	0
1996	0	459	746
1997	0	459	756
1998	0	459	766
1999	0	459	776
2000	0	459	787
2001	0	459	796
2002	0	459	807
2003	0	459	818
2004	0	459	828
2005	0	459	841
2006	0	459	852
2007	0	459	866
2008	0	459	879
2009	0	459	892
2010	0	459	908
	4,243	6,883	12,319

APPENDIX S

ZONE 19 - PROVIDENCE, RI

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Providence Harbor	(Port 19)			Wildlife Abundance Tables Fish & Shellfish Grams per Square Meter			
Port & Subzone	Species Category	Species Code	Species Name	Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
1901	101	1	American Shad	.0043	.0043	.0043	.0043
1901	101	2	Blueback Herring	0.0000	.0142	.0142	0.0000
1901	102	3	Menhaden	5.5000	5.5000	5.5000	5.5000
1901	102	4	Atlantic Herring	.2099	.0077	.0543	1.8188
1901	102	5	Butterfish	1.3779	11.8360	4.5926	0.0000
1901	102	7	Atlantic Mackerel	2.9000	2.9000	2.9000	2.9000
1901	102	32	King Mackerel	.0190	.0370	.0190	0.0000
1901	102	44	Striped Mullet	.0480	.0480	.0480	.0480
1901	102	128	Northern Searobin	.0636	0.0000	.0035	0.0000
1901	103	8	Bluefish	.8200	1.4000	.8200	0.0000
1901	103	9	Striped Bass	.0047	.0047	.0094	.0094
1901	103	10	Goosefish	.1749	.3497	.1749	.1749
1901	103	11	Weakfish	.2400	.2400	.2400	.2400
1901	104	13	Swordfish	.0330	.0330	.0330	.0330
1901	104	14	Shark	.0041	.0041	.0041	.0041
1901	104	15	Smooth Dogfish	0.0000	.1749	0.0000	0.0000
1901	104	15	Spiny Dogfish	0.0000	0.0000	.1749	0.0000
1901	105	16	Yellowtail Flounder	.4600	.4600	.4600	.4600
1901	105	17	Summer Flounder	.9178	.4239	.2120	0.0000
1901	105	20	Winter Flounder	.2000	.2000	.2000	.2000
1901	105	251	Four Spot Flounder	2.1548	1.2719	.1410	.0349
1901	105	251	Sand Flounder	1.2008	1.2008	1.4765	1.2369
1901	106	24	Silver Hake	3.9057	.9466	1.2541	1.2782
1901	106	25	Red Hake	.6600	.6600	.6600	.6600
1901	106	27	Scup	9.6239	2.4905	1.1340	0.0000
1901	106	29	Black Sea Bass	.0300	.0300	.0300	.0300
1901	106	29	Tilefish	.0330	.0330	.0330	.0330
1901	106	35	Atlantic Croaker	.0470	.0470	.0470	.0470
1901	106	67	Tautog	0.0000	0.0000	.0349	0.0000
1901	106	109	Longhorn Sculpin	0.0000	0.0000	.1696	.0282
1901	106	116	Little Skate	2.3848	2.1733	4.0271	4.7171
1901	106	199	Other	.4200	.4200	.4200	.4200
1901	106	252	Squirrel Hake	.4737	.1186	.3785	.3785
1901	106	254	Ocean Pout	.1589	0.0000	.0525	.6622
1901	106	355	Conner	.1060	0.0000	0.0000	0.0000
1901	107	202	Quahaug	7.2000	7.2000	7.2000	7.2000
1901	107	203	Sea Scallop	.0600	.0600	.0600	.0600
1901	107	299	Other Invertebrates	.0480	.0480	.0480	.0480
1901	108	204	American Lobster	.4558	.2367	.2474	.0247
1901	108	206	Red Crab	.2300	.2300	.2300	.2300
1901	109	207	Squid	0.0000	0.0000	727.0000	0.0000
1902	101	1	American Shad	.1200	.0580	0.0000	.0580
1902	101	2	Blueback Herring	0.0000	0.0000	.0142	0.0000
1902	101	31	Hickory Shad	.0120	.0060	0.0000	.0060
1902	102	3	Menhaden	22.1000	22.4000	11.2000	0.0000
1902	102	4	Atl.Herring	.0700	0.0000	.0856	.0154
1902	102	5	Butterfish	.0200	.4400	.1100	0.0000
1902	102	5	Butterfish	.7070	6.7839	2.1910	0.0000
1902	102	7	Atlantic Mackerel	.0040	0.0000	0.0000	.0040
1902	102	32	King Mackerel	.0030	0.0000	0.0000	.0030
1902	102	33	Spanish Mackerel	.0210	0.0000	0.0000	.0210
1902	102	34	Harvestfish	.0010	.0010	.0010	.0010
1902	102	127	Silver Sides	4.0000	5.0000	7.8000	.1000

APPENDIX S

ZONE 19 - PROVIDENCE, RI (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Providence Harbor		(Port 19)		Wildlife Abundance Tables Fish & Shellfish Grams per Square Meter			
Port & Subzone	Species Category	Species Code	Species Name	Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
1902	102	128	Northern Sea Robin	0.0000	.0070	0.0000	0.0000
1902	102	128	Stripped Sea Robin	.0035	.0070	.0064	0.0000
1902	103	8	Bluefish	.2700	.3200	.3200	0.0000
1902	103	9	Striped Bass	.2600	.4700	.4200	.4200
1902	103	11	Weakfish	.0955	9.0441	.3471	0.0000
1902	105	17	Summer Flounder	.1399	.8479	.8479	0.0000
1902	105	18	American Plaice	.0170	.0090	.0090	.0100
1902	105	20	Winter Flounder	2.0900	.7700	1.4600	1.5400
1902	105	113	Sanddab Flounder	.5100	.1900	.2500	.2800
1902	105	251	Four Spot Flounder	0.0000	0.0000	.1059	0.0000
1902	105	251	Sand Flounder	.0819	.0834	.1152	.0045
1902	105	251	Sand Flounder	.2469	.2120	.6709	.2120
1902	106	24	Silver Hake	0.0000	.0469	.8046	0.0000
1902	106	25	Red Hake	.0040	.0020	.0030	.0030
1902	106	26	White Hake	.0090	.0140	.0050	0.0000
1902	106	27	Scup	.2200	.3300	.0900	0.0000
1902	106	27	Scup	23.9079	25.6943	2.0932	0.0000
1902	106	29	Black Sea Bass	.0010	.0010	.0010	.0010
1902	106	35	Atlantic Croaker	.3700	.3700	.3700	0.0000
1902	106	36	Drum	.0020	.0020	.0020	0.0000
1902	106	37	Spot	.0960	.0490	0.0000	.0490
1902	106	38	Yellow Perch	.0020	.0020	.0020	.0020
1902	106	39	Carp	.0250	.0250	.0250	.0250
1902	106	40	Eels	.1400	.1400	.1400	.1400
1902	106	67	Tautog	.1060	.0349	0.0000	0.0000
1902	106	109	Grubby Sculpin	0.0000	0.0000	.0070	.0140
1902	106	116	Little Skate	.1049	0.0000	.7409	.0525
1902	107	211	Soft Clam	.1700	.1700	.1700	.1700
1902	107	212	Oyster	1.9000	1.9000	1.9000	1.9000
1902	107	213	Hard Clam	.0800	.0800	.0800	.0800
1902	107	213	Hard Clam	2250.0000	2250.0000	2250.0000	2250.0000
1902	107	214	Conch	.0660	.0660	.0660	.0660
1902	108	204	Lobster	.3215	.5581	.5303	.0262
1902	108	209	Soft Blue Crab	4.1000	4.1000	4.1000	4.1000
1902	108	210	Hard Blue Crab	.2000	.2000	0.0000	0.0000
1902	108	217	Calico Crab	22.0000	66.0000	22.0000	0.0000
1902	108	217	Cancer Crab	156.0000	29.2000	110.0000	22.0000
1902	108	217	Horseshoe Crab	55.0000	110.0000	55.0000	0.0000
1902	108	217	Spider Crab	44.0000	29.2000	110.0000	8.8000
1902	109	207	Squid	.2500	3.8800	.1400	0.0000
1903	101	1	American Shad	.1200	.0580	0.0000	.0580
1903	101	2	Blueback Herring	0.0000	0.0000	.0142	0.0000
1903	101	31	Hickory Shad	.0120	.0060	0.0000	.0060
1903	102	3	Menhaden	22.1000	22.4000	11.2000	0.0000
1903	102	4	Atl.Herring	.0700	0.0000	.0856	.0154
1903	102	5	Butterfish	.0200	.4400	.1100	0.0000
1903	102	5	Butterfish	.7070	6.7839	2.1910	0.0000
1903	102	7	Atlantic Mackerel	.0040	0.0000	0.0000	.0040
1903	102	32	King Mackerel	.0030	0.0000	0.0000	.0030
1903	102	33	Spanish Mackerel	.0210	0.0000	0.0000	.0210
1903	102	34	Harvestfish	.0010	.0010	.0010	.0010
1903	102	127	Silver Sides	4.0000	5.0000	7.8000	.1000
1903	102	128	Northern Sea Robin	0.0000	.0070	0.0000	0.0000

APPENDIX S

ZONE 19 - PROVIDENCE, RI (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Providence Harbor (Port 19)

Wildlife Abundance Tables
Fish & Shellfish
Grams per Square Meter

Port & Subzone	Species Category	Species Code	Species Name	Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
1903	102	128	Stripped Sea Robin	.0035	.0070	.0064	0.0000
1903	103	8	Bluefish	.2700	.3200	.3200	0.0000
1903	103	9	Striped Bass	.2600	.4700	.4200	.4200
1903	103	11	Weakfish	.0955	9.0441	.3471	0.0000
1903	105	17	Summer Flounder	.1399	.8479	.8479	0.0000
1903	105	18	American Plaice	.0170	.0090	.0090	.0100
1903	105	20	Winter Flounder	2.0900	.7700	1.4600	1.5400
1903	105	113	Sanddab Flounder	.5100	.1900	.2500	.2800
1903	105	251	Four Spot Flounder	0.0000	0.0000	.1059	0.0000
1903	105	251	Sand Flounder	.0819	.0834	.1152	.0045
1903	105	251	Sand Flounder	.2469	.2120	.6709	.2120
1903	106	24	Silver Hake	0.0000	.0469	.8046	0.0000
1903	106	25	Red Hake	.0040	.0020	.0030	.0030
1903	106	26	White Hake	.0090	.0140	.0050	0.0000
1903	106	27	Scup	.2200	.3300	.0900	0.0000
1903	106	27	Scup	23.9079	25.6943	2.0932	0.0000
1903	106	29	Black Sea Bass	.0010	.0010	.0010	.0010
1903	106	35	Atlantic Croaker	.3700	.3700	.3700	0.0000
1903	106	36	Drum	.0020	.0020	.0020	0.0000
1903	106	37	Spot	.0960	.0490	0.0000	.0490
1903	106	38	Yellow Perch	.0020	.0020	.0020	.0020
1903	106	39	Carp	.0250	.0250	.0250	.0250
1903	106	40	Eels	.1400	.1400	.1400	.1400
1903	106	67	Tautog	.1060	.0349	0.0000	0.0000
1903	106	109	Grubby Sculpin	0.0000	0.0000	.0070	.0140
1903	106	116	Little Skate	.1049	0.0000	.7409	.0525
1903	107	211	Soft Clam	.1700	.1700	.1700	.1700
1903	107	212	Oyster	1.9000	1.9000	1.9000	1.9000
1903	107	213	Hard Clam	.0800	.0800	.0800	.0800
1903	107	214	Conch	.0660	.0660	.0660	.0660
1903	108	204	Lobster	.3215	.5581	.5303	.0262
1903	108	209	Soft Blue Crab	4.1000	4.1000	4.1000	4.1000
1903	108	210	Hard Blue Crab	.2000	.2000	0.0000	0.0000
1903	108	217	Calico Crab	22.0000	66.0000	22.0000	0.0000
1903	108	217	Cancer Crab	156.0000	29.2000	110.0000	22.0000
1903	108	217	Horseshoe Crab	55.0000	110.0000	55.0000	0.0000
1903	108	217	Spider Crab	44.0000	29.2000	110.0000	8.8000
1903	109	207	Squid	.2500	3.8800	.1400	0.0000

APPENDIX S

ZONE 19 - PROVIDENCE, RI (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Providence Harbor		(Port 19)		Wildlife Abundance Tables Fish & Shellfish Larvae Numbers per Square Meter			
Port & Subzone	Species Category	Species Code	Species Name	Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
1901	202	1003	Atlantic Menhaden	0.0000	.2500	.2500	0.0000
1901	202	1004	Atlantic Herring	0.0000	0.0000	.5000	.2500
1901	202	1005	Butterfish	0.0000	5.0000	0.0000	0.0000
1901	202	1006	Pollock	0.0000	0.0000	0.0000	.5000
1901	202	1007	Atlantic Mackerel	55.0000	.5000	0.0000	0.0000
1901	202	1043	Anchovy	0.0000	10.0000	0.0000	0.0000
1901	202	1110	Sand Lance	5.0000	0.0000	5.0000	55.0000
1901	203	1008	Bluefish	0.0000	5.0000	0.0000	0.0000
1901	203	1199	Larvae	.0110	.1900	.0054	0.0000
1901	205	1016	Yellow Tail Flounder	5.5000	0.0000	0.0000	0.0000
1901	205	1017	Summer Flounder	0.0000	0.0000	2.5000	0.0000
1901	205	1019	Witchflounder	.5000	0.0000	0.0000	0.0000
1901	205	1251	Four Spot Flounder	1.6500	1.6500	1.6500	0.0000
1901	205	1251	Gulf Stream Flounder	0.0000	1.0000	0.0000	0.0000
1901	205	1251	Windowpane	0.0000	.5000	2.5000	0.0000
1901	206	1021	Atlantic Cod	.5000	0.0000	.5000	5.5000
1901	206	1022	Haddock	.5000	5.5000	0.0000	0.0000
1901	206	1024	Silver Hake	0.0000	50.0000	5.0000	0.0000
1901	206	1025	Hakes	0.0000	5.0000	0.0000	0.0000
1901	206	1027	Scup	0.0000	.2900	.2900	0.0000
1901	206	1035	Atlantic Croaker	0.0000	0.0000	.5000	0.0000
1901	206	1040	Cuskeel	.3400	.3400	.3400	0.0000
1901	206	1112	Seasnail	.2300	.2300	.2300	0.0000
1901	206	1255	Cunner	.5000	55.0000	0.0000	0.0000
1901	207	1199	Larvae	2.0000	20.0000	2.0000	0.0000
1901	208	204	American Lobster	0.0000	.0052	0.0000	0.0000
1901	208	1199	Larvae	.0016	.0042	0.0000	0.0000
1902	202	1003	Menhaden	18.6769	19.1410	.0095	.0095
1902	202	1004	Atlantic Herring	.0427	0.0000	0.0000	0.0000
1902	202	1005	Butterfish	0.0000	.0998	.0665	0.0000
1902	202	1007	Atlantic Mackerel	.5430	.0089	0.0000	0.0000
1902	202	1043	Anchovy	.5096	12.7322	.9975	.6650
1902	202	1110	Sand Lance	.5374	.0423	0.0000	.3302
1902	202	1127	Silverside	.9776	.3222	0.0000	0.0000
1902	202	1128	Sea Robin	0.0000	.1340	0.0000	0.0000
1902	202	1248	Radiated Shanny	.0494	0.0000	0.0000	0.0000
1902	202	1256	Stickleback	.0048	0.0000	0.0000	0.0000
1902	203	1008	Bluefish	0.0000	.0048	0.0000	0.0000
1902	203	1011	Weakfish	.3365	.4091	0.0000	0.0000
1902	203	1199	Larvae	.0640	1.1000	.0310	0.0000
1902	205	1017	Summer Flounder	0.0000	.0143	.0143	.0048
1902	205	1020	Winter Flounder	1.4241	.0004	0.0000	.4123
1902	205	1199	Larvae	10.9000	6.5000	3.6000	.0400
1902	205	1251	Fourspot Flounder	0.0000	.0428	0.0000	0.0000
1902	205	1251	Windowpane	.7112	.3657	0.0000	0.0000
1902	206	1021	Atlantic Cod	.0570	.0380	0.0000	.0190
1902	206	1022	Haddock	.0143	0.0000	0.0000	0.0000
1902	206	1024	Silver Hake	0.0000	.0570	.0190	0.0000
1902	206	1025	Hake	.0190	.0285	.0190	0.0000
1902	206	1040	American Eel	.0095	0.0000	0.0000	.0190
1902	206	1064	Northern Kingfish	.0095	.0190	0.0000	0.0000
1902	206	1067	Tautog	1.1618	1.3647	0.0000	0.0000
1902	206	1109	Sculpin	2.6505	1.7670	0.0000	0.0000
1902	206	1112	Lumpfish	.0095	0.0000	0.0000	0.0000

APPENDIX S

ZONE 19 - PROVIDENCE, RI (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Providence Harbor		(Port 19)		Wildlife Abundance Tables Fish & Shellfish Larvae Numbers per Square Meter			
Port & Subzone	Species Category	Species Code	Species Name	Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
1902	206	1114	Rock Gunnel	0.0000	0.0000	.0142	.0428
1902	206	1120	Seaboard Gobi	.0658	.4413	0.0000	0.0000
1902	206	1123	White Perch	.0537	.1610	0.0000	0.0000
1902	206	1199	Centropristes Striatus	0.0000	.0048	0.0000	0.0000
1902	206	1243	Hogchoker	0.0000	.0124	0.0000	0.0000
1902	206	1244	Northern Pipefish	.0257	.0769	.0257	0.0000
1902	206	1252	Fourbeard Rockling	.0500	.0046	0.0000	0.0000
1902	206	1255	Cunner	.8355	.9001	0.0000	0.0000
1902	206	1257	Northern Puffer	.0190	.0570	0.0000	0.0000
1902	207	1199	Larvae	100.0000	1000.0000	100.0000	0.0000
1902	208	1199	Larvae	.0160	.0420	0.0000	0.0000
1903	202	1003	Menhaden	59.7351	61.4977	.0095	.0095
1903	202	1004	Atlantic Herring	.0427	0.0000	0.0000	0.0000
1903	202	1005	Butterfish	0.0000	.0998	.0665	0.0000
1903	202	1007	Atlantic Mackerel	.0779	.0109	0.0000	0.0000
1903	202	1043	Anchovy	1.5654	30.9766	.9975	.6650
1903	202	1110	Sand Lance	.5266	.0423	0.0000	.0471
1903	202	1127	Silverside	1.6730	.7115	0.0000	0.0000
1903	202	1128	Sea Robin	0.0000	.1340	0.0000	0.0000
1903	202	1248	Radiated Shanny	.0494	0.0000	0.0000	0.0000
1903	202	1256	Stickleback	.0048	0.0000	0.0000	0.0000
1903	203	1008	Bluefish	0.0000	.0048	0.0000	0.0000
1903	203	1011	Weakfish	.5289	1.0851	0.0000	0.0000
1903	203	1199	Larvae	.0640	1.1000	.0310	0.0000
1903	205	1017	Summer Flounder	0.0000	.0143	.0143	.0048
1903	205	1020	Winter Flounder	2.4382	.0028	0.0000	.2091
1903	205	1199	Larvae	10.9000	6.5000	3.6000	.0400
1903	205	1251	Fourspot Flounder	0.0000	.0428	0.0000	0.0000
1903	205	1251	Windowpane	1.7041	.8689	0.0000	0.0000
1903	206	1021	Atlantic Cod	.0570	.0380	0.0000	.0190
1903	206	1022	Haddock	.0143	0.0000	0.0000	0.0000
1903	206	1024	Silver Hake	0.0000	.0570	.0190	0.0000
1903	206	1025	Hake	.0190	.0285	.0190	0.0000
1903	206	1040	American Eel	.0095	0.0000	0.0000	.0190
1903	206	1064	Northern Kingfish	.0095	.0190	0.0000	0.0000
1903	206	1067	Tautog	2.0119	3.0668	0.0000	0.0000
1903	206	1109	Sculpin	2.6505	1.7670	0.0000	0.0000
1903	206	1112	Lumpfish	.0095	0.0000	0.0000	0.0000
1903	206	1114	Rock Gunnel	0.0000	0.0000	.0142	.0428
1903	206	1120	Seaboard Gobi	.0986	1.6921	0.0000	0.0000
1903	206	1123	White Perch	.0537	.1610	0.0000	0.0000
1903	206	1199	Centropristes Striatus	0.0000	.0048	0.0000	0.0000
1903	206	1243	Hogchoker	0.0000	.0124	0.0000	0.0000
1903	206	1244	Northern Pipefish	.0257	.0769	.0257	0.0000
1903	206	1252	Fourbeard Rockling	.0391	.0029	0.0000	0.0000
1903	206	1255	Cunner	.7693	2.1939	0.0000	0.0000
1903	206	1257	Northern Puffer	.0190	.0570	0.0000	0.0000
1903	207	1199	Larvae	100.0000	1000.0000	100.0000	0.0000
1903	208	1199	Larvae	.0160	.0420	0.0000	0.0000

APPENDIX S

ZONE 19 - PROVIDENCE, RI (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Providence Harbor Port & Subzone	Species Category	(Port 19) Species Code	Species Name	Wildlife Abundance Tables Birds Numbers per Square Kilometer Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
1901	111	514	Swans	0.0000	0.0000	0.0000	.0157
1901	111	517	Common Loon	.0600	0.0000	.0200	.0200
1901	111	517	Red Throated Loon	.0200	0.0000	.0100	0.0000
1901	112	571	Sandpiper,Plover,Turnstone	.0002	0.0000	0.0000	.0354
1901	112	572	Oystercatcher,Avocet,Stilt	0.0000	.0001	0.0000	0.0000
1901	113	530	Cormorant	7.2932	10.4188	0.0000	0.0000
1901	113	531	Gulls	8.8?00	.8300	4.2500	8.7300
1901	113	532	Black Legged Kittiwake	.3200	0.0000	.5000	1.1100
1901	113	533	Terns	.1900	.0200	.0100	0.0000
1901	113	534	Audubons Shearwater	0.0000	.0500	.0100	0.0000
1901	113	534	Cory's Shearwater	.0100	2.0000	.4400	0.0000
1901	113	534	Greater Shearwater	.2400	2.8100	4.0900	.0100
1901	113	534	Manx Shearwater	0.0000	.0100	.0100	0.0000
1901	113	534	Sooty Shearwater	.1300	.6300	.0100	.0100
1901	113	535	Other Jaeger	.0100	.0100	.0200	.0100
1901	113	535	Parasitic Jaeger	0.0000	0.0000	.0100	0.0000
1901	113	535	Pomarine Jaeger	0.0000	.0200	.1200	.0100
1901	113	535	Skua	.0100	.0100	.0100	.0100
1901	113	536	Northern Fulmar	.9100	.0100	.0700	2.8100
1901	113	537	Storm Petrels	1.0600	5.7400	.0200	0.0000
1901	113	537	White Faced Storm Petrel	0.0000	0.0000	.0100	0.0000
1901	113	538	Dovekie	.0100	0.0000	0.0000	.0100
1901	113	538	Large Alcid	.0500	0.0000	.0100	.0700
1901	113	538	Murre	.0100	0.0000	0.0000	.0400
1901	113	538	Razorbill	.0500	0.0000	0.0000	.1600
1901	113	540	Atlantic Puffin	.0100	.0100	0.0000	0.0000
1901	113	542	Other Phalarope	.0700	.0200	.0100	0.0000
1901	113	542	Red Necked Phalarope	0.0000	.0100	0.0000	0.0000
1901	113	542	Red Phalarope	.9200	.0400	.4800	0.0000
1901	113	543	Albatross	0.0000	.0100	0.0000	0.0000
1901	113	547	Northern Gannet	1.1800	.0100	.3300	1.6000
1901	114	583	Hawks	0.0000	0.0000	0.0000	.0010
1901	114	584	Owls	0.0000	0.0000	0.0000	.0010
1902	111	511	Duck	160.0000	0.0000	160.0000	320.0000
1902	111	512	Coot	1.6000	0.0000	1.6000	3.1000
1902	111	513	Goose	205.0000	0.0000	205.0000	410.0000
1902	111	514	Swan	20.0000	20.0000	20.0000	20.0000
1902	112	570	Shore Birds	376.0000	144.6000	94.8000	11.7000
1902	113	530	Sea Birds	20.3000	7.6000	8.1000	9.9000
1903	111	511	Duck	160.0000	0.0000	160.0000	320.0000
1903	111	512	Coot	1.6000	0.0000	1.6000	3.1000
1903	111	513	Goose	205.0000	0.0000	205.0000	410.0000
1903	111	514	Swan	20.0000	20.0000	20.0000	20.0000
1903	112	570	Shore Birds	376.0000	144.6000	94.8000	11.7000
1903	113	530	Sea Birds	20.3000	7.6000	8.1000	9.9000

APPENDIX T

WILMINGTON, NC

(ZONE 20)

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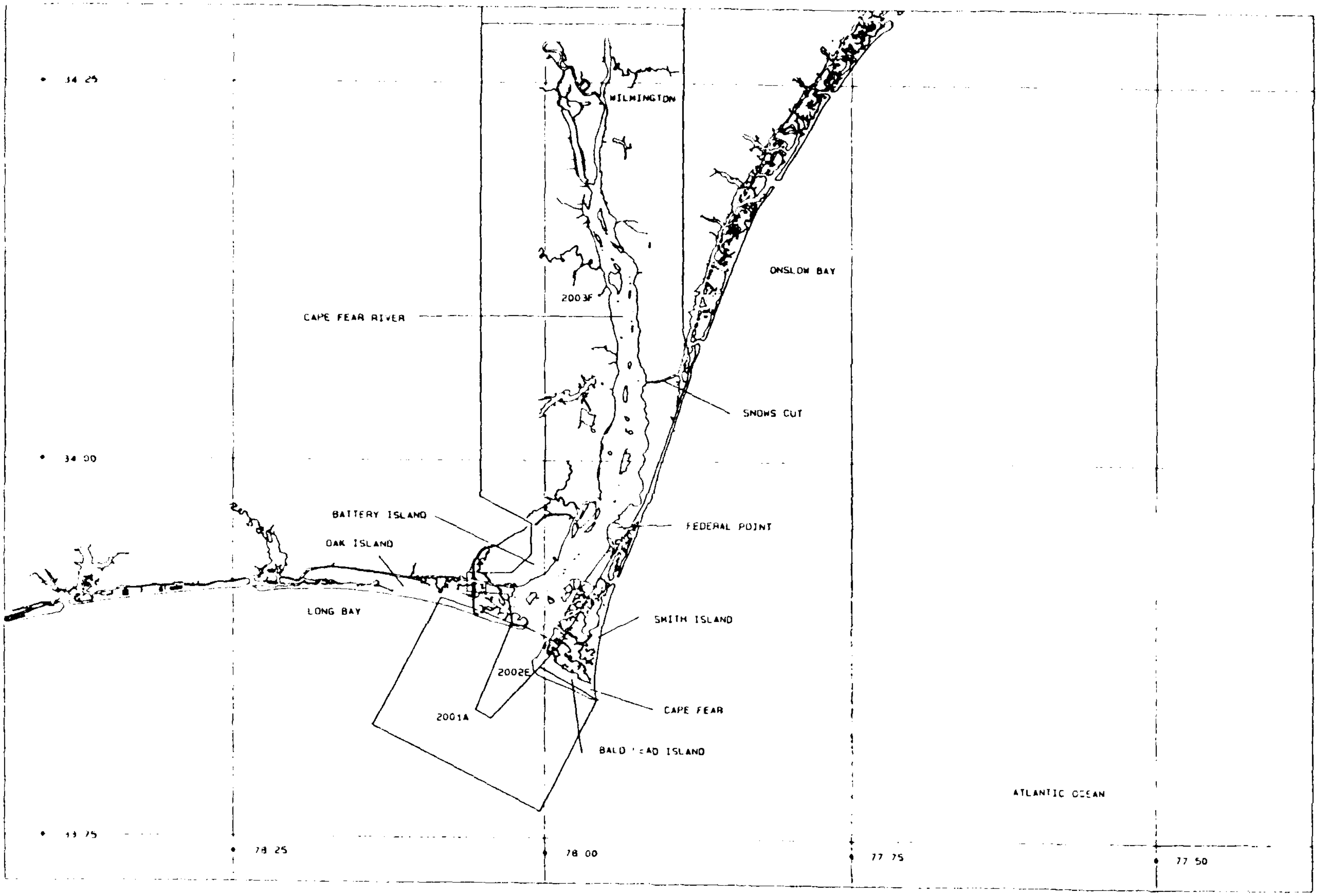
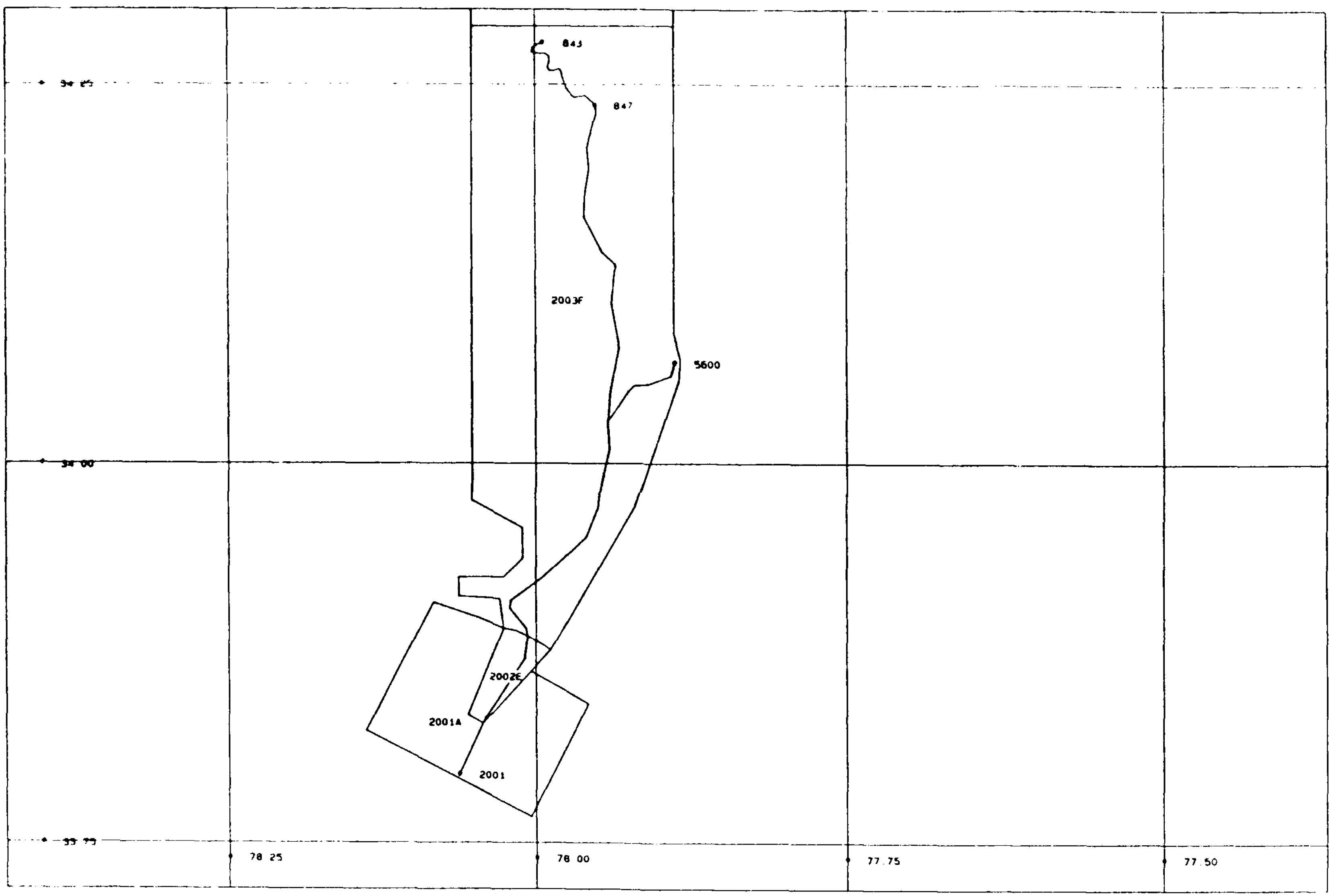
STUDY ZONE MAPS

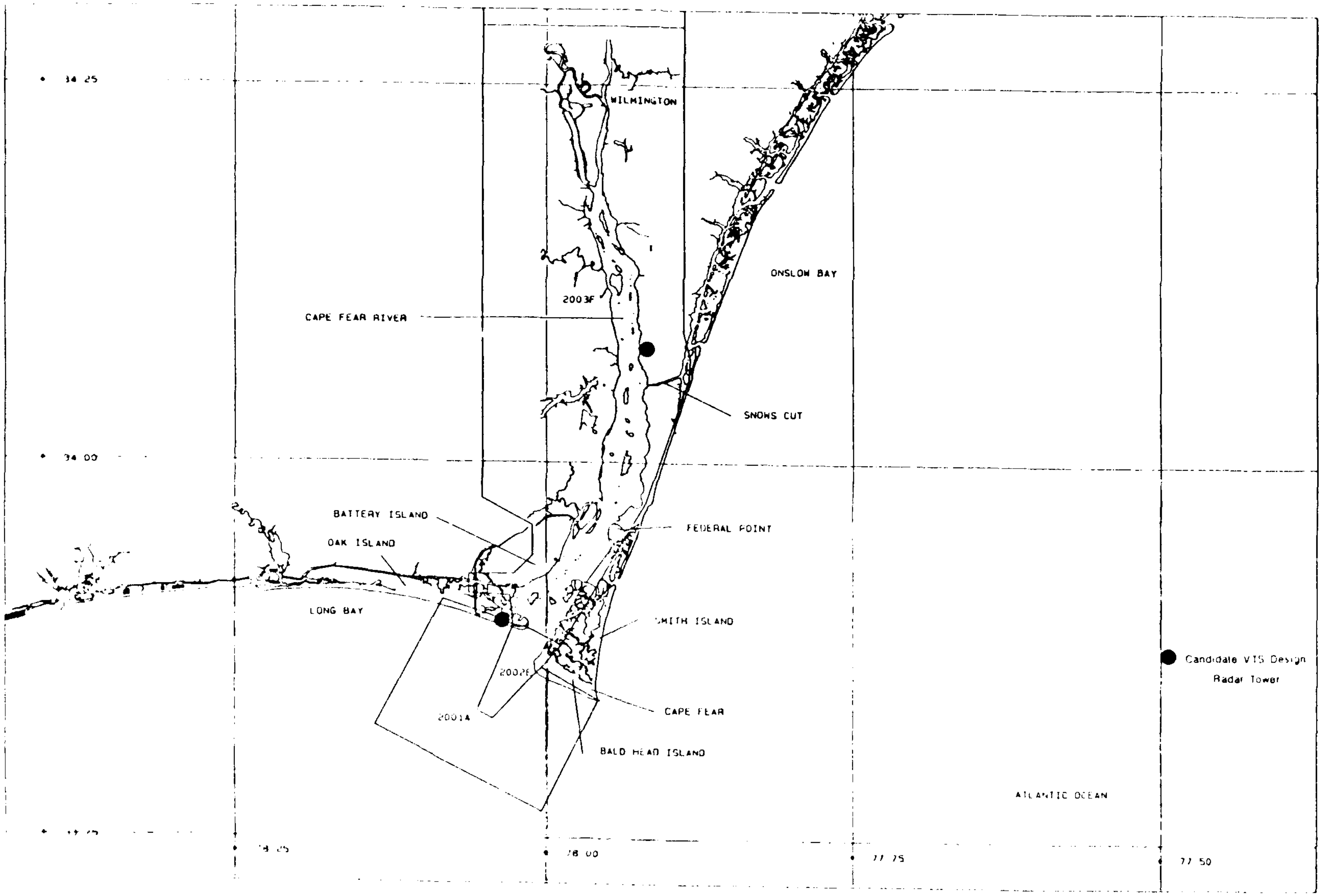


ZONE 20 - WILMINGTON, NC - ZONE AND SUBZONE BOUNDARIES



ZONE 20 - WILMINGTON, NC - DOMINANT VESSEL ROUTES AND COE WATERWAY CODES

ZONE 20 - WILMINGTON, NC - BASE PERIOD (10 YEAR) VESSEL CASUALTIES



ZONE 20 - WILMINGTON, NC - CANDIDATE VTS DESIGN RADAR LOCATIONS

CANDIDATE VTS DESIGN REPORT

FOR

WILMINGTON, NC

(ZONE 20)

Prepared for:
U.S. Department of Transportation
Research and Special Programs Administration
John A. Volpe National Transportation Systems Center
Cambridge, MA 02142

Prepared by:
NAVCOM Systems, Inc.,
7203 Gateway Court
Manassas, VA 22110

July 1991

OVERVIEW

The Candidate VTS Design described in this appendix is one of 23 developed for all the study zones included in the study. This appendix documents the task performed, under Contract DTRS-57-88-C-00088 Technical Task Directive 13, as an integral part of the total Port Needs Study. The ultimate product of this task effort is an informed preliminary technical assessment of the approximate cost to the Federal Government to implement and operate a state-of-the-art VTS system. This appendix does not contain a comprehensive definition of the VTS operating requirements nor does it propose a final VTS specification suitable for implementation.

In order to consistently estimate the life cycle costs of a VTS system in each of the study zones, a "Candidate VTS Design" has been defined for each study zone using a uniform set of design criteria. Each study zone Candidate VTS Design is a composite of generic modules selected from a master list of 18 state-of-the-art surveillance modules, communications and display technology. Among the surveillance modules in the master list are several levels of technical performance from which the selection is made for application to each study sub-zone to address the local navigational surveillance needs and conditions. The Candidate VTS Design in each study zone represents a consistent application of the surveillance modules at the sub-zone level. The sub-zone surveillance technology is subsequently integrated into a total system for the study zone via state-of-the-art communications and display consoles at the Vessel Traffic Center (VTC) in each zone.

The application of the surveillance modules in each sub-zone responds to the technical requirements of that sub-zone as perceived by the study team. The Candidate VTS Design represents a preliminary engineering judgement on the appropriate level of technology in each sub-zone. The Candidate VTS Design may be considered as an informed judgement made by the contractor study team for the sole purpose of developing cost estimates that are consistent across the 23 study zones and suitable for benefit/cost comparisons among the study zones and initial budget planning and implementation priorities. The approach used to calculate VTS system costs for all 23 study zones is found in Volume III, Technical Supplement.

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VTS DESIGN FOR WILMINGTON, NC

1.0 SCOPE

This report includes a port survey and a VTS design for Wilmington, North Carolina. The port survey is based on a review of all pertinent literature including navigational charts. The methodology used to produce the VTS design entails coupling the problems identified in the port survey with solutions offered by state-of-the-art technology as identified in the VTS Technology Survey, November 1990. When possible, technological advances which permit manpower reductions are applied. Not all VTS problems are amenable to strictly technological solutions; some require changes in procedures and/or enforcement. These situations are identified where they occur.

2.0 WILMINGTON PORT SURVEY

2.1 INTRODUCTION

This survey report is based exclusively upon review of available literature and examination of the charts for the area and its approaches. The information thus gained has been evaluated and interpreted based upon the Survey Team's experience as professional mariners and in vessel traffic management systems.

The Survey Area includes the Port of Wilmington, the Cape Fear River from its entrance to the head of deep-draft navigation at Wilmington, and the seaward approaches to the Cape Fear River.

Wilmington is the leading port of North Carolina. Its facilities are located well inland from the sea along the Cape Fear River, much of the navigable portions of which consist of narrow man-made channels. While not one of the major petroleum/petrochemical ports, an appreciable quantity of potential pollutants and hazardous cargo is moved through an environmentally sensitive area.

The surveyed area is host to an important Military Ocean Terminal and its proximity to the North Carolina bases of the U. S. Marine Corps makes it an important staging port.

2.2 OVERVIEW OF THE PORT

Climate within the Survey Area is considered unusually mild for its latitude. Poor visibility occurs about 22 days per year, averaging three days per month during November through April. During such periods, it is not unusual for the river itself to be free of fog while at the bar and offshore it is thick. Gale force winds are infrequent, and those which do occur are usually associated with tropical disturbances.

The diurnal tidal range is 4.5' at the entrance, 4.1' at Southport, and 4.2' at Wilmington itself. Tidal ranges can be modified

considerably by river freshets caused by heavy rains, and currents can be as high as 3.5 knots at maximum ebb. Although the direction of the currents generally coincides with the channel axis definite cross-channel components occur near the entrance.

A Federal project provides a 40' channel over the ocean bar and 38' from the bar up river 24 miles to the turning basin off the southern portion of Wilmington. From the southern turning basin Project depths are progressively reduced to 25 feet at the head of deep-draft navigation in the Northeast Cape Fear River, several miles above Wilmington. Project widths vary from 550' to 400'. The Project dredging has not been completed, and charted tabulations and Notices to Mariners should be consulted for the latest data.

The channel is well marked by buoys and fixed aids, including ranges, but because of its narrow width and strong currents ships drawing 37' enter only at high tides and during daylight. Maximum outbound draft is limited to 36', with movement only at high tide and during daylight. Ships drawing around 33' or less may move at any time. The COLREGS Demarcation Line lies across the main ship channel at a line between Oak Island Light and the abandoned lighthouse at Bald Head Island.

Pilotage is compulsory from the bar to the limits of deep-draft navigation for all foreign-flag ships and U. S.-flag ships under register in the foreign trade, and optional for U. S.-flag ships in the coastwise trade with who have on board a pilot licensed by the Federal Government. Pilot service is provided by the Wilmington Cape Fear Pilots Association, who maintain an office and lookout tower at Southport, near the mouth of the Cape Fear River. The Pilot Boarding Area is about one mile to seaward of Cape Fear Entrance Lighted Bell Buoy 2CF. The Pilots Association guards VHF-FM Channels 16 and 18A, and use Channels 12 and 18A for working.

Deep-draft ships entering the Cape Fear River must give Frying Pan Shoals a wide berth and keep clear of charted obstructions near the seaward end of the entrance channel. Approach navigation is assisted by good Loran-C coverage, with excellent crossing angles. The coastal area is low-lying and generally provides poor returns for radar navigation. There are ample fixed aids to navigation for landfall under conditions of good visibility. The areas on both sides of the bar entrance channel contain dangerous shoals, and the bottom between the inside of the bar and Cape Fear River Light 34 is primarily mud and sand. Between Light 34 and Light 37 the bottom is primarily rock, and "softens" again above Light 37. Some shoaling is occurring within the Project channels.

There are no designated anchorages within the river, but the portion just south of Southport and the turning basin off Greenfield Creek (Wilmington) is frequently used by deep-draft shipping awaiting river passage. The area at Southport is also used as a harbor of refuge by coastwise traffic awaiting improvement in

weather conditions. Holding ground there is fair, but effects of tidal currents are strongly felt. For ships awaiting entrance to the river good holding ground is found about 0.6 mile southeast of Cape Far River Entrance Lighted Bell Buoy 2CF.

The Wilmington-Cape Fear River area has over 40 terminals and other waterfront facilities, a complete description of which is given by Report No. 12, U. S. Army Corps of Engineers Port Series reports. A Restricted Area has been established around the Sunny Point Military Ocean Terminal. Southport, near the river mouth and at the southern junction of the river with the ICW, supports a large concentration of recreational and fishing boats. ICW traffic uses the main channel between Southport and the Upper Midnight Channel, where the ICW again separates from the Cape Fear River, and there a car ferry operates in the main channel between Pierce Creek and Federal Point. Because of commercial activity in and around Wilmington itself, few recreational and fishing boats use the upper portions of the river.

2.3 EXISTING TRAFFIC MANAGEMENT

Except for the general U. S. Army Corps of Engineers (COE) general regulations for tributaries flowing into the Atlantic Ocean (33CFR207), there are no formal harbor or river traffic regulations as such.

2.3.1 Restricted Area

A Restricted Area has been established to protect the Sunny Point Military Ocean Terminal. The area consists of that portion of the Cape Fear River west of the main ship channel between Cape Far River Buoys 23A and 31A. Except in emergencies, vessels may enter the restricted area only with authorization by the Commander, Sunny Point Army Terminal (Reference 1).

2.3.2 Informal Practices

Pilots have established a practice of taking ships drawing 37' into the river only at high tides and during daylight. They limit the outbound maximum draft to 36', and move such ships only at high tide and during daylight. Ships drawing around 33' or less may be moved at any time. Movements are also adjusted to prevent awkward meetings, but there appear to be no standard criteria for such decisions.

2.4 VESSEL TRAFFIC

The Port of Wilmington handled about 7.7 million tons of cargo in 1987, 1.8 million tons of which were petroleum products (gasoline, jet fuel, heating fuel--Reference 2). 296 tankers called that year, out of approximately 900 total ship calls. In addition to

deep-draft shipping Wilmington has a moderate barge trade, with barge movements in 1987 totalling 1585 (Reference 3).

Cargoes of most significant interest to VTS design are movements of petrochemicals, including anhydrous ammonia, and military shipments to and from the Sunny Point Military Ocean Terminal. The Intracoastal Waterway (ICW) and main shipping channel share the same route for nearly ten miles. Although firm data about ICW traffic is not available, indications are that much of it consists of transiting pleasure craft, with the main flow southbound to Florida in the fall and northbound in the late spring. There is some barge traffic in the ICW but its nature and volume has not been quantified.

There is limited barge traffic from Wilmington north to Fayetteville, the head of shoal-draft navigation about 100 miles above Wilmington. Tow size is limited by three U. S. Army Corps of Engineers-operated locks and dams between Navassa and Fayetteville. The lock dimensions are 200' x 40' x 9' over the sills.

2.5 ENVIRONMENTAL SENSITIVITY

The Cape Fear River is a protected breeding area for several species of aquatic life. Much of the river is bordered by sensitive wetlands, which form an important habitat for aquatic migratory birds. The North Carolina beaches above and below the Cape Fear River mouth are considered to be environmentally sensitive, important from the residential and recreational aspect as well as refuge and breeding areas for aquatic birds, mammals and fish.

2.6 PORT SUB-ZONES

The study area was examined to determine appropriate sub-zones, using the methodology based upon the "confined-complex", "open-complex", "confined-simple" and "open-simple" system employed by the Canadian VTS Study in 1984 (Reference 4). Briefly stated, "open" and "confined" address the influence of geography upon a ship's ability to maneuver; and "simple" vs "complex" is descriptive of the nature of the interactions between ships within those geographic areas. This basic matrix was overlaid by a subjective assessment of appropriate traffic management/risk amelioration measures in order to derive sub-zones within which VTS needs are homogeneous, or nearly so.

2.6.1 Sub-Zone I -- Offshore Approaches (NOAA Chart 11536)

This sub-zone lies offshore of a line drawn from the abandoned lighthouse on Bald Head Island south to 33^0-46.5'N 78^0-00'W, thence west to 33^0-46.5'N 78^0-05'W and then north to the shoreline.

The sub-zone provides opportunity for inbound ships to establish communications with the pilots and Vessel Traffic Center well in

advance of arrival at the sea buoy (Cape Fear Entrance Channel Lighted Bell Buoy 2CF). This permits the adjustment of arrival times, if required, to facilitate safe entry. The use of this sub-zone to establish communications and queuing also permits the Cape Fear River to be managed as "one-way" if desired.

The Vessel Traffic Service should be capable of providing navigational assistance in that portion of the sub-zone within twenty miles of Cape Fear.

The sub-zone is "open-simple."

2.6.2 Sub-Zone II -- Cape Fear River Entrance (NOAA Chart 11537)

This sub-zone lies shoreward of Sub-Zone I (a line drawn from the abandoned lighthouse on Bald Head Island south to 33^0-46.5'W 78^0-00'W, thence west to 33^0-46.5'N 78^0-05'W and then north to the shoreline) and seaward of the COLREGS Demarcation Line at the Cape Fear River entrance.

The sub-zone contains the Pilot Boarding Area and the recommended offshore anchorage, as well as the Southport anchorage and the junction of the ICW. Considerable small craft activity is centered upon Southport, and ICW traffic shares the main ship channel in the northern portion of the sub-zone.

VTS capabilities should include surveillance of the Southport anchorage area, regulation of its use when required, and the ability to smoothly and safely combine the traffic flows of the main channel and the ICW. Cross-track navigational assistance is not feasible because of the narrowness of the main channel, but along-track positioning is important to management of traffic.

The sub-zone is "confined-complex".

2.6.3 Sub-Zone III -- Cape Fear River (NOAA Chart 11537)

This sub-zone lies up river from the inshore boundary of Sub-Zone II (the COLREGS Demarcation Line at the Cape Fear River entrance) and a line across the main ship channel at 34^0-10'N. It includes that portion of the ICW east of the main ship channel to the U. S. Highway 421 bridge; and the ICW west of the main ship channel to the fixed bridge to Oak Island at Yaupon Beach.

ICW traffic shares the main ship channel for nearly 10 miles, as does the Pierce Creek-Federal Point ferry. The Sunny River Military Ocean Terminal Restricted Area lies within the sub-zone.

VTS capabilities should include the ability to smoothly and safely combine the traffic flows of the main channel and the ICW. This includes regulating the queue of deep-draft traffic as necessary to prevent dangerous meetings. Cross-track navigational assistance is not feasible because of the narrowness of the main channel, but

along-track positioning is important to manacement of traffic. The ability to assist in the enforcement of the Restricted Area, t least with respect to vessels over 20 meters length overall (LOA) may be an important aspect, as may be the ability to give priority to the movement of military shipments.

The sub-zone is classified as "confined-complex."

2.6.4 Sub-Zone IV -- Port of Wilmington (NOAA Chart 11537)

The sub-zone extends from the northern boundary of Sub-Zone III (a line across the main ship channel at 34^0-10'N) to the head of deep-draft navigation on the Northeast Cape Fear River approximately 0.5 mile above the Upper Turning Basin and on the Cape Fear River at the U. S. Highway 421 Bridge.

The sub-zone includes the lower turning basin, which is occasionally used as an anchorage for ships awaiting berths or passage down river.

VTS capabilities should include the ability to regulate the queue of deep-draft traffic as necessary to prevent dangerous meetings, and to manage flow to avoid interference with ships maneuvering to make or clear berths. Cross-track navigational assistance is not feasible because of the narrowness of the main channel, but along-track positioning is important to management of traffic. The VTS should be able to maintain surveillance over that portion of the lower turning basin used as an anchorage and control its use, if required.

The sub-zone is classified as "confined-complex."

2.6.5 Sub-Zone V -- Upper Cape Fear and NE Cape Fear Rivers (NOAA Chart 11537)

This sub-zone consists of those portions of the Northeast Cape Fear River approximately 0.5 mile above the Upper Turning Basin and the Cape Fear River above the U. S. Highway 421 Bridge.

The sub-zone serves primarily as a means of establishing communications with and obtaining management information from downbound traffic before it enters Sub-Zone IV.

The sub-zone is classified as "confined-simple."

2.7 PROBLEM AREA IDENTIFIERS

2.7.1 PAI I-1. Frying Pan Shoals

Frying Pan Shoals is dangerous to ships particularly during periods of reduced visibility. The VTC should be capable of providing navigational assistance, if required, to ships operating in the vicinity of the shoals.

2.7.2 PAI II-1. Jay Bird and Bald Head Shoals

The Jay Bird and Bald Head Shoals is traversed by a 500' wide channel within which meetings of large ships should not occur. This is particularly true under circumstances where there is a strong cross-channel set.

2.7.3 PAI III-1. Baldhead Caswell Channel

Baldhead Caswell Channel is an area where significant alterations of course occur at a point where currents may introduce definite cross-channel set. While the narrowness of the channels rules out other than along-track navigational assistance, the VTC should have the capability to prevent meetings or overtakings within these portions of the channel.

2.7.4 PAI III-2. Southport (Includes Baldhead Caswell Channel)

The Southport area is potentially the most active and congested within this study area. ICW joins and departs the main ship channel at a point where major course alterations must be made, where ships anchor, and where there is significant small craft activity. Surveillance and capability to manage the anchorage and traffic flows is required.

2.7.5 PAI III-3. Snows Marsh Channel

A car ferry runs between Pierce Creek and Federal Point, using the main ship channel. Ferry entry into the channel must be coordinated to merge safely with the main traffic flow.

2.7.6 PAI III-4. Sunny Point

The VTC should be capable of assisting in enforcement of the Sunny Point Restricted Area, and to insure the smooth merging and departure of shipping with the main channel traffic which serves Sunny Point facilities.

2.7.7 PAI IV-1. Wilmington

The VTC should have the capability to maintain surveillance of the lower turning basin anchorage area, and to regulate the flow of

traffic within Wilmington harbor proper. Control over departures of outbound shipping is required to prevent dangerous meetings.

3.0 WILMINGTON VTS DESIGN

3.1 INTRODUCTION

A detailed survey of the Port of Wilmington is the basis for this design. An approach to costing VTS systems is outlined in Vol. III, Technical Supplement and a method of categorizing surveillance sensors into "modules" has also been developed. These modules are defined in terms of cost and performance and are to be applied to all VTS designs in this study. The applicability of Automatic Dependent Surveillance (ADS) technology is also discussed in this report. The five sub-zones defined in the harbor survey remain the same.

Traffic management requirements for each sub-zone are developed from PAI analysis. Table 3-1 lists in tabular form a summation of the problems identified and the management required by sub-zone.

The hardware and software selected for this design provide the level of surveillance justified by the problems identified in each sub-zone. A secondary consideration is to locate all VTS assets so that they are sufficient for the sub-zone in question and can contribute to adjoining sub-zones to achieve maximum usage. All specific equipments are then selected based on perceived surveillance requirements and overall VTS system architecture.

3.1.1 VTS Design Approach

The choice of surveillance sensors is dependent on the VTS mission. For the purposes of this design, the VTS mission is defined as that which insures the safety of navigation and the protection of the environment. In order to accomplish this mission, mandatory participation of all vessels over 20 meters is essential. The Vessel Traffic Center (VTC) must provide navigation safety advice to all vessels. The VTS in the United States will have no facilitation of commerce role nor will it offer piloting assistance of any kind.

The primary criteria for selection of adequate surveillance sensors are:

- o Percentage of vessels of the desired minimum size detected in designated surveillance areas
- o Percentage of lost tracks
- o Accuracy of the position and track obtained
- o Reliability of the surveillance system

TABLE 3-1. WILMINGTON, NC PROBLEM AREA IDENTIFIERS

SZ	LOCATION	PROBLEM	MANAGEMENT
I	Offshore Approaches	Data catchment area for inbound shipping. Navigational assistance may be required. Queuing of inbound traffic must begin in Sub-zone I.	Have real-time knowledge of vessel movements, locations. Enter inbound ship information into database. Correlate ships' ID with radar contacts.
II	Cape Fear River Entrance	Potential congestion. Navigational assistance may be required. Queuing necessary to prevent unacceptable meetings.	Have real-time knowledge of vessel movements. Be able to provide movement management advice as required.
III	Cape Fear River	Narrow channels where meetings, overtakings must be managed. The potential for localized congestion. Queuing control required, coupled with anchorage management.	Have real-time knowledge of vessel movements and locations. Provide movement management advice, control Southport anchorage.
IV	Port of Wilmington	Narrow channels where meetings, overtakings must be managed. Potential for congestion. Queuing control required for outbound shipping.	Have real-time knowledge of vessel movements and locations. Provide movement management advice.
V	Upper Cape Fear River and NE Cape Fear River	Data catchment area for vessels downbound to Sub-zone IV. Detect non-participating traffic which will enter Sub-zone IV.	Have real-time knowledge of vessel movements and locations. Provide movement management advice. Enter inbound traffic into database.

- o Timeliness of the data obtained

- o Ability to interpret and use the data obtained

Secondary criteria are:

- o Cost of the VTS system -- reduction of manpower by the use of technology

- o Expandability -- increased VTS responsibility, area, and/or support of other missions

Active surveillance sensors including radar, communications, and closed circuit television (CCTV) installations are used when detection and tracking of vessels is paramount to providing safety advice. These devices are considered fail safe in that it is known with certainty when they have failed. The performance characteristics of these sensors are known from operational VTS worldwide experience. In this design they are selected to assure that the necessary operational criteria identified for each sub-zone is realized.

Many dependent surveillance techniques are possible. These range from voice radio reporting of required VTS data to automatic position and identification recording devices that can be interrogated from shore known as Automatic Dependent Surveillance (ADS) devices. The position and/or movement reporting form of dependent surveillance is used extensively in existing VTS systems. The major regions of current use are those which do not require active surveillance. To apply ADS technology to a specific sub-zone within a VTS zone the following additional criteria must be considered:

- o The number and class of vessels interacting in the sub-zone and which of these interactions are important to the VTS mission. Obviously all vessel classes of interest must be appropriately equipped. This requires that all vessels of the classes selected which will ever pass through this sub-zone must be equipped with an ADS device. This requirement to detect so many different vessels argues against the use of ADS. In areas where only one class of vessel is of interest, ADS is more easily implemented.

- o The interactions or transits to be monitored must not demand that the surveillance be fail safe, i.e. positively detecting failures. This type of surveillance is related to position reporting in that it may not always function or be used properly and the VTS has limited control over its operation.

- o It must be determined that if active surveillance is not justified, the additional information obtained from ADS over position reporting is necessary.

- o If the class or group of vessels to be monitored is a "controllable" group, ADS can be easily implemented and satisfactory operation more readily achieved. Controllable means a clearly defined subset of vessels, e.g. a specific barge company; vessels carrying a specific cargo, etc.

- o The number of different vessels in each class of interest that passes through the sub-zone in question must be determined. This number must be known to accurately estimate the cost of selecting this option for this sub-zone.

- o A specific ADS solution for one sub-zone in one harbor may affect all the VTS designs for all the other sub-zones in all the other harbors.

3.1.2 Assumptions

The design of a VTS system for the Wilmington VTS zone starts with a set of assumptions based on the detailed survey and other data. These assumptions are as follows:

- o As recommended by the IMO, all vessels of 20 meters or more in length are required to participate in the VTS. Participation is defined (at a minimum) as monitoring the VTS frequency and reporting as required.

- o The VTS system is implemented with the cooperation and assistance of the port authorities, pilots associations, and marine exchange, if any. The existing facilities, services, and procedures established and operated by these organizations are major elements of an integrated VTS system as defined in the IMO VTS Guidelines.

- o The life-cycle of all system hardware is ten years.

3.2 DESIGN DECISIONS (FIGURE 3-1)

3.2.1 Hardware Location and Selection

3.2.1.1 Sub-Zone III

Oak Island	1 Module 3 radar 1 Module 10 VHF 1 Module 11 VHF

	RADAR						ADS			VHF		MET.		HYD.		DF	CCTV		COMMENTS
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
Surveil lance Modules																			Comms/Radar/DF coverage from Sub-Zone III
Sub Zones																			Comms/Radar coverage from Sub-Zone III
III	1		1							2	1		1						
IV										1	1	1							

FIGURE 3-1. WILMINGTON, NC SURVEILLANCE SURVEY

East Shore of River above Loran Station	1 Module 1 radar 1 Module 10 VHF 1 Module 13 MET

3.2.1.2 Sub-Zone IV

Port of Wilmington	1 Module 10 VHF 1 Module 11 VHF 1 Module 12 MET

3.2.2 Vessel Traffic Center

The design of the hardware and software should be modern and capable of operating with reduced staff levels and no loss of effectiveness. One watchstander with an integrated data workstation and decision aiding software can effectively manage the activity in this port. This Vessel Traffic Center concept demands that the watchstander be separated from any other harbor/port information requests. The Center must be structured so that such requests are controlled by a bulletin board type interface. One officer-in-charge and one clerk are also required for the proper administration of the facility.

The Vessel Traffic Center is located in Wilmington at a location with good visual surveillance of the port. The center is to employ the following equipment:

3.2.2.1 VTS Console

This console provides total data integration from all sensors in all sectors. These data are graphically shown on raster scan, high light level, color displays. A data display is also provided. Console design architecture is general purpose computer based, open architecture, bus organized, allowing operation of the system as a local area network (LAN). Data interchange with other facilities by modem is provided as well as interface with the U.S. Coast Guard standard terminal. The design allows board level modification and expansion. Features of the software and hardware provided are:

- o Software written in a high level language.

- o Software providing the total integration of data from all VTS sensors.

- o Layering of data in at least four layers to be operator selectable.

- o The ability to sector data including sector to sector handoff of targets.

- The ability to accept external digital data derived from transmissions of shipboard transponders or other sources and integrate the information with all other sensor data.

- Automatic and/or manual acquisition of radar targets including automatic tracking and target ID assignments. Guard zones with automatic acquisition of all targets entering the zone.

- Several warning levels of vessel interaction designed to direct attention to developing situations rather than a simple CPA alarm strategy.

- Complete vessel monitoring and alarm capability including anchor watch, CPA, TCPA, track history, adjustable target velocity vectors, restricted area penetration and maneuvering monitor is provided. Additional warning and/or alarm features allowed by programming changes in high level language.

- Complete modern color graphics capability with offset and zoom

- Complete harbor navigation aid monitoring capability including buoy position, light status, etc.

- Remote control of all radars and radar interfaces as well as radar data processing including site-to-site integration, clutter suppression, scan conversion and target extraction.

- Complete track projection capability which can predict and/or analyze future interactions based on current position, destination and velocity.

- The capability of constructing a complete vessel data base and interfacing it to the real-time data display from the VTS sensors.

3.2.2.2 Communications Console

This console is capable of remotely operating the proposed transmitting/receiving sites and allowing transmission and monitoring on all required frequencies. The console provides operating positions each to be capable of complete communications control. It is capable of modular expansion if other remote communications sites are added.

3.2.2.3 Supervisor Control and Data Acquisition (SCADA) Equipment

A SCADA capability is provided to the major module level at remote sites so that the watchstander can determine the status of the entire VTS system. A graphic readout is provided in block diagram form indicating operational status of all elements in the system. Security monitoring of remote sites is also included.

3.2.2.4 Recording Equipment

Time synchronized video and audio recording equipment is to be provided. This equipment is capable of recording and playing back the data presented to the VTS watchstander and his reaction to the situation. An extra set of recording equipment is to be installed for redundancy purposes.

3.3 COST ESTIMATES

3.3.1 General

Vol. III, Technical Supplement discusses a generalized approach to estimating VTS system costs. This approach is based on interviews with system designers and purchasers of recently constructed systems. The cost of the Wilmington VTS system has been estimated using this approach and is detailed below. The assumptions made in estimating these costs are listed in Paragraph 3.1.2.

3.3.2 Hardware (x $1000)

<u>Vessel Traffic Center</u>	non-recurring	recurring(10-yr)
VTS Console (1 workstation & all software)	500	
Communications console	100	
Recording Equipment	50	
SCADA Equipment (2 radar sites)	200	
Sub-total:	850	400

<u>Sub-Zone I--Offshore Approaches (NOAA Chart 11536)</u>

Comms/radar/DF coverage from Sub-Zone III.

<u>Sub-Zone II--Cape Fear River Entrance (NOAA Chart 11537)</u>

Comms/radar coverage from Sub-Zone III.

Sub-Zone III--Cape Fear River (NOAA Chart 11537)

1 Module 1 radar	310	310
1 Module 3 radar	400	400
2 Module 10 VHF	38	26
1 Module 11 VHF	48	20
1 Module 13 MET	40	5
Sub-total:	836	761

Sub-Zone IV--Port of Wilmington (NOAA Chart 11537)

1 Module 10 VHF	19	13
1 Module 11 VHF	48	20
1 Module 12 MET	20	5
Sub-total:	87	38
HARDWARE TOTALS:	1773	1199

3.3.3 Project Totals (x $1000)

Non-recurring

Hardware	$1773
Management, Engineering, etc. (50%) Assumptions: Turnkey system, Procurement by integ.contractor, good manufacturer support, some software provided, System Manual required	887
Installation site integration (20%) Assumptions: Complete installation by contractor, remote access no serious problem, many widespread sites	355
Spares & Training (10%)	177
Civil Engineering 2 remote radar sites, a VTC in Oak Island, remote comms and WX sensors installations, land acquisition	1000
PROJECT ESTIMATE:	4192
Data Base Management System	300
TOTAL: (non-recurring)	$ 4492

Recurring (10 year)

Hardware	1199
1 Watchstander x 5 = 5 man/years @ 50K x 10	2500
1 Officer-in-Charge	500
1 Clerk	500
TOTAL: (recurring) (10-year life)	$ 4699
TOTAL 10-YEAR PROJECT COST:	$ 9191

REFERENCES

1. 33CFR334.450

2. Summary Statistics on Leading U.S. Ports, Center for Marine Conservation, Washington, D.C., 1990.

3. Summary Statistics on Leading U.S. Ports, Center for Marine Conservation, Washington, D.C. 1990.

4. Final Report, National Vessel Traffic Services Study (TP5965E) Canadian Coast Guard, Ottawa 1984, pp. 89-91.

GLOSSARY

ADS: Automatic Dependent Surveillance

ARPA: Automatic Radar Plotting Aid.

"CONFINED-COMPLEX": a combination of terms relating to the geography and the nature of the interactions between ships. See Final Report National Vessel Traffic Services Study (TP-5965E), Canadian Coast Guard, Ottawa, October 1984, pp.89-91.

"CONFINED-SIMPLE": a combination terms relating to the geography and the nature of the interactions between ships. See Final Report National Vessel Traffic Services Study (TP-5965E), Canadian Coast Guard, Ottawa, October 1984, pp.89-91.

COTP: Captain of the Port

CCTV: closed circuit television

COLREGS LINE: a demarcation line delineating those waters upon which international regulations for the prevention of collisions at sea apply.

CPA: closest point of approach

DBMS: data base management system

DF: direction finder

FAA: Federal Aviation Administration

GIS: Geographic Information System

ICW: Intracoastal Waterway

IMO: International Maritime Organization

KW: Kilowatt

LAN: local area network

LLOYD'S LIST: a listing of all merchant vessels of the world including their physical characteristics. Published by Lloyd's of London.

LNG: liquified natural gas

NOAA: National Oceanic and Atmospheric Administration

"OPEN-COMPLEX": a combination of terms relating to the geography and the nature of the interactions between ships. See Final Report National Vessel Traffic Services Study (TP-5965E), Canadian Coast Guard, Ottawa, October 1984, pp. 89-91.

"OPEN-SIMPLE": a combination of terms relating to the geography and the nature of the interactions between ships. See Final Report National Vessel Traffic Services Study (TP-5965E), Canadian Coast Guard, Ottawa, October 1984, pp. 89-91.

PAI: Problem Area Identifier

PRECAUTIONARY AREA: an area normally an intersection, entrance to, or exit from a traffic separation scheme where vessel interactions are unpredictable

SCADA: Supervisor Control and Data Acquisition

TCPA: time of closest point of approach

TRAFFIC SEPARATION SCHEME: routes incorporating traffic separation to increase the safety of navigation, particularly in converging areas of high traffic density.

VHF: very high frequency

VTC: vessel traffic center

VTS: vessel traffic services

STUDY ZONE INPUT DATA AND OUTPUT STATISTICS

Appendix T Zone 20 Wilmington, NC

TABLE 1 Assignment of COE Waterway Codes to Subzones 8/06/91

COE Waterway		Name
Subzone 2001A		
843	A	CAPE FEAR RIVER ABOVE WILMINGTON, N. C.
847	A	WILMINGTON HARBOR, N. C.
5600	A	ATLANTIC INTRACOASTAL WATERWAY (CONSOLIDATED REPORT)BETWEEN
Subzone 2002E		
843	A	CAPE FEAR RIVER ABOVE WILMINGTON, N. C.
847	A	WILMINGTON HARBOR, N. C.
5600	A	ATLANTIC INTRACOASTAL WATERWAY (CONSOLIDATED REPORT)BETWEEN
Subzone 2003F		
843	A	CAPE FEAR RIVER ABOVE WILMINGTON, N. C.
843	B	CAPE FEAR RIVER ABOVE WILMINGTON, N. C.
847	A	WILMINGTON HARBOR, N. C.
847	B	WILMINGTON HARBOR, N. C.
5600	A	ATLANTIC INTRACOASTAL WATERWAY (CONSOLIDATED REPORT)BETWEEN
5600	B	ATLANTIC INTRACOASTAL WATERWAY (CONSOLIDATED REPORT)BETWEEN

TABLE 2 Base Year 1987 Cargo Tons by Subzone, Commodity, and Vessel Type

Subzone 2001A

Comm. Code	Name	Dry Cargo	Tanker	Dry Cargo Barge Tow	Tanker Barge Tow	Total
1	FARM PRODUCTS	130,666	0	30,987	0	161,653
2	FOREST PRODUCTS	497	0	0	0	497
3	FISHERIES PRODUCTS	440	0	0	0	440
4	MINING PRODUCTS, NEC	672,748	0	780,119	0	1,452,867
5	PROC. FOODS & MFTRS, NEC	2,756,857	0	1,875,356	0	4,632,213
6	WASTE OF MANUFACTURING	45,638	0	123,907	0	169,545
1492	SULPHUR, DRY	8,021	0	0	0	8,021
1493	SULPHUR, LIQUID	0	0	0	574,750	574,750
2810	SODIUM HYDROXIDE (CAUSTI	39,479	0	78,008	0	117,487
2811	CRUDE PROD-COAL TAR-PET	2,337	0	0	0	2,337
2813	ALCOHOLS	0	340,467	0	190,421	530,888
2818	SULPHURIC ACID	112	0	0	19,890	20,002
2871	NITROGEN CHEM FERTILIZER	0	163,690	0	98,947	262,637
2872	POTASSIC CHEM FERTILIZER	51,518	0	0	0	51,518
2873	PHOSPHA CHEM FERTILIZERS	0	0	223	0	223
2911	GASOLINE, INCL NATURAL	0	638,442	0	83,156	721,598
2912	JET FUEL	0	0	0	265,641	265,641
2913	KEROSENE	0	63,185	0	2,918	66,103
2914	DISTILLATE FUEL OIL	0	386,482	0	77,488	463,970
2915	RESIDUAL FUEL OIL	0	719,632	0	921,265	1,640,897
2916	LUBRIC OILS-GREASES	0	1,131	0	0	1,131
2917	NAPHTHA, PETRLM SOLVENTS	0	118,188	0	7,638	125,826
2921	LIQUI PETR-COAL-NATR GAS	0	32,273	0	1,490	33,763
	Subzone Total :	3,708,313	2,463,490	2,888,600	2,243,604	11,304,007

Subzone 2002E

Comm. Code	Name	Dry Cargo	Tanker	Dry Cargo Barge Tow	Tanker Barge Tow	Total
1	FARM PRODUCTS	130,666	0	30,987	0	161,653
2	FOREST PRODUCTS	497	0	0	0	497
3	FISHERIES PRODUCTS	440	0	0	0	440
4	MINING PRODUCTS, NEC	672,748	0	780,119	0	1,452,867
5	PROC. FOODS & MFTRS, NEC	2,756,857	0	1,875,356	0	4,632,213
6	WASTE OF MANUFACTURING	45,638	0	123,907	0	169,545
1492	SULPHUR, DRY	8,021	0	0	0	8,021
1493	SULPHUR, LIQUID	0	0	0	574,750	574,750
2810	SODIUM HYDROXIDE (CAUSTI	39,479	0	78,008	0	117,487
2811	CRUDE PROD-COAL TAR-PET	2,337	0	0	0	2,337
2813	ALCOHOLS	0	340,467	0	190,421	530,888
2818	SULPHURIC ACID	112	0	0	19,890	20,002
2871	NITROGEN CHEM FERTILIZER	0	163,690	0	98,947	262,637
2872	POTASSIC CHEM FERTILIZER	51,518	0	0	0	51,518
2873	PHOSPHA CHEM FERTILIZERS	0	0	223	0	223
2911	GASOLINE, INCL NATURAL	0	638,442	0	83,156	721,598
2912	JET FUEL	0	0	0	265,641	265,641
2913	KEROSENE	0	63,185	0	2,918	66,103
2914	DISTILLATE FUEL OIL	0	386,482	0	77,488	463,970
2915	RESIDUAL FUEL OIL	0	719,632	0	921,265	1,640,897
2916	LUBRIC OILS-GREASES	0	1,131	0	0	1,131
2917	NAPHTHA, PETRLM SOLVENTS	0	118,188	0	7,638	125,826
2921	LIQUI PETR-COAL-NATR GAS	0	32,273	0	1,490	33,763
	Subzone Total :	3,708,313	2,463,490	2,888,600	2,243,604	11,304,007

TABLE 2 Base Year 1987 Cargo Tons by Subzone, Commodity, and Vessel Type

Subzone 2003F

Comm. Code	Name	Dry Cargo	Tanker	Dry Cargo Barge Tow	Tanker Barge Tow	Total
1	FARM PRODUCTS	130,666	0	30,987	0	161,653
2	FOREST PRODUCTS	497	0	0	0	497
3	FISHERIES PRODUCTS	440	0	0	0	440
4	MINING PRODUCTS, NEC	672,748	0	780,119	0	1,452,867
5	PROC. FOODS & MFTRS, NEC	2,756,857	0	1,875,356	0	4,632,213
6	WASTE OF MANUFACTURING	45,638	0	123,907	0	169,545
1492	SULPHUR, DRY	8,021	0	0	0	8,021
1493	SULPHUR, LIQUID	0	0	0	574,750	574,750
2810	SODIUM HYDROXIDE (CAUSTI	39,479	0	78,008	0	117,487
2811	CRUDE PROD-COAL TAR-PET	2,337	0	0	0	2,337
2813	ALCOHOLS	0	340,467	0	190,421	530,888
2818	SULPHURIC ACID	112	0	0	19,890	20,002
2871	NITROGEN CHEM FERTILIZER	0	163,690	0	98,947	262,637
2872	POTASSIC CHEM FERTILIZER	51,518	0	0	0	51,518
2873	PHOSPHA CHEM FERTILIZERS	0	0	223	0	223
2911	GASOLINE, INCL NATURAL	0	638,442	0	83,156	721,598
2912	JET FUEL	0	0	0	265,641	265,641
2913	KEROSENE	0	63,185	0	2,918	66,103
2914	DISTILLATE FUEL OIL	0	386,482	0	77,488	463,970
2915	RESIDUAL FUEL OIL	0	719,632	0	921,265	1,640,897
2916	LUBRIC OILS-GREASES	0	1,131	0	0	1,131
2917	NAPHTHA, PETRLM SOLVENTS	0	118,188	0	7,638	125,826
2921	LIQUI PETR-COAL-NATR GAS	0	32,273	0	1,490	33,763
	Subzone Total :	3,708,313	2,463,490	2,888,600	2,243,604	11,304,007

TABLE 3 Base Year (1987)
Vessel Transits by Subzone, Vessel Type, and Size.

Vessel Type	Large	Medium	Small	Total
Subzone : 2001A				
Passenger	0	4	0	4
Dry Cargo	204	825	1,223	2,252
Tanker	157	395	41	593
Dry Cargo Barge Tow	0	0	679	679
Tanker Barge Tow	41	0	392	433
Tug/Tow Boat	66	0	579	645
Subzone Total:	468	1,224	2,914	4,606
Subzone : 2002E				
Passenger	0	4	0	4
Dry Cargo	204	825	1,223	2,252
Tanker	157	395	41	593
Dry Cargo Barge Tow	0	0	679	679
Tanker Barge Tow	41	0	392	433
Tug/Tow Boat	66	0	579	645
Subzone Total:	468	1,224	2,914	4,606
Subzone : 2003F				
Passenger	0	4	16,604	16,608
Dry Cargo	204	825	6,117	7,146
Tanker	157	395	41	593
Dry Cargo Barge Tow	0	0	3,393	3,393
Tanker Barge Tow	41	0	1,960	2,001
Tug/Tow Boat	66	0	2,894	2,960
Subzone Total:	468	1,224	31,008	32,700

Note: Sum of all vessel transits within each study subzone.

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Appendix T   ZONE   20 Wilmington, NC

TABLE 3 Base Year (1987)
Vessel Transits by Suzone, Vessel Type, Size.

ZONE TOTALS

ZONE   20 Wilmington, NC

Vessel Type	Large	Medium	Small	Total
Passenger	0	4	16,604	16,608
Dry Cargo	204	825	6,117	7,146
Tanker	157	395	41	593
Dry Cargo Barge Tow	0	0	3,393	3,393
Tanker Barge Tow	41	0	1,960	2,001
Tug/Tow Boat	66	0	2,894	2,960
Zone Total:	468	1,224	31,008	32,700

Note: Sum of all arrivals/departures to/from all terminals within the Study Zone.

Appendix T ZONE 20 Wilmington, NC

TABLE 4 Barges Per Tow - Average Factors by COE Waterway 8/6/91

COE Code	Waterway Name	Dry Barge	Tank Barge
	SUBZONE 2001A		
843	CAPE FEAR RIVER ABOVE WILMINGTON, N. C.	2	2
847	WILMINGTON HARBOR, N. C.(SEE ALSO PORT OF WILMINGTON, N. C. FOR PORT DATA)	2	2
5600	ATLANTIC INTRACOASTAL WATERWAY (CONSOLIDATED REPORT)BETWEEN NORFOLK, VA., AND THE ST. JOHNS RIVER, FLA.	2	2
	SUBZONE 2002E		
843	CAPE FEAR RIVER ABOVE WILMINGTON, N. C.	2	2
847	WILMINGTON HARBOR, N. C.(SEE ALSO PORT OF WILMINGTON, N. C. FOR PORT DATA)	2	2
5600	ATLANTIC INTRACOASTAL WATERWAY (CONSOLIDATED REPORT)BETWEEN NORFOLK, VA., AND THE ST. JOHNS RIVER, FLA.	2	2
	SUBZONE 2003F		
843	CAPE FEAR RIVER ABOVE WILMINGTON, N. C.	2	2
847	WILMINGTON HARBOR, N. C.(SEE ALSO PORT OF WILMINGTON, N. C. FOR PORT DATA)	2	2
5600	ATLANTIC INTRACOASTAL WATERWAY (CONSOLIDATED REPORT)BETWEEN NORFOLK, VA., AND THE ST. JOHNS RIVER, FLA.	2	2

NOTE: Average size of tows arriving/departing terminals within the waterway. Sizes of other tows transiting the area may differ.

Appendix T Zone 20 Wilmington, NC

TABLE 5 Other Local Vessels by Subzone *7/21/91*

Subzone	Name	Number of Vessels	Vessels per Square Mile
2001A		1,752	36.50
2002E		1,752	273.75
2003F		11,333	333.32
	Total for Zone	14,837	167.84

Note: State registered (1989/90) vessels estimated to be operated within the Subzone.

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Appendix T ZONE 20 Wilmington, NC

TABLE 6.1 Forecast 1995
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 2001A				
Passenger	0	4	0	4
Dry Cargo	278	1,078	7,252	8,608
Tanker	176	435	44	655
Dry Cargo Tow	0	0	7,426	7,426
Tanker Tow	41	0	3,217	3,257
Tug/Tow Boat	0	0	(3,779)	(3,779)
Subzone Total:	495	1,517	14,160	16,172
Subzone : 2002E				
Passenger	0	4	14,599	14,604
Dry Cargo	278	1,078	7,252	8,608
Tanker	176	435	44	655
Dry Cargo Tow	0	0	7,426	7,426
Tanker Tow	41	0	3,217	3,257
Tug/Tow Boat	0	0	(3,779)	(3,779)
Subzone Total:	495	1,517	28,759	30,771
Subzone : 2003F				
Passenger	0	4	17,168	17,172
Dry Cargo	278	1,078	7,252	8,608
Tanker	176	435	44	655
Dry Cargo Tow	0		7,426	7,426
Tanker Tow	41	0	3,217	3,257
Tug/Tow Boat	0	0	(3,779)	(3,779)
Subzone Total:	495	1,517	31,328	33,339

Note: Sum of all vessel transits within each study subzone.

Appendix T ZONE 20 Wilmington, NC

TABLE 6.2 Forecast 2000
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 2001A				
Passenger	0	4	0	4
Dry Cargo	339	1,299	8,066	9,704
Tanker	190	467	48	705
Dry Cargo Tow	0	0	8,195	8,195
Tanker Tow	44	0	3,474	3,517
Tug/Tow Boat	0	0	(4,113)	(4,113)
Subzone Total:	573	1,770	15,669	18,012
Subzone : 2002E				
Passenger	0	4	15,095	15,099
Dry Cargo	339	1,299	8,066	9,704
Tanker	190	467	48	705
Dry Cargo Tow	0	0	8,195	8,195
Tanker Tow	44	0	3,474	3,517
Tug/Tow Boat	0	0	(4,113)	(4,113)
Subzone Total:	573	1,770	30,764	33,107
Subzone : 2003F				
Passenger	0	4	17,751	17,755
Dry Cargo	339	1,299	8,066	9,704
Tanker	190	467	48	705
Dry Cargo Tow	0	0	8,195	8,195
Tanker Tow	44	0	3,474	3,517
Tug/Tow Boat	0	0	(4,113)	(4,113)
Subzone Total:	573	1,770	33,420	35,762

Note: Sum of all vessel transits within each study subzone.

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Appendix T ZONE 20 Wilmington, NC

TABLE 6.3 Forecast 2005
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 2001A				
Passenger	0	4	0	4
Dry Cargo	415	1,579	8,980	10,974
Tanker	205	502	51	758
Dry Cargo Tow	0	0	9,044	9,044
Tanker Tow	48	0	3,753	3,800
Tug/Tow Boat	0	0	(4,467)	(4,467)
Subzone Total:	668	2,085	17,361	20,114
Subzone : 2002E				
Passenger	0	4	15,538	15,542
Dry Cargo	415	1,579	8,980	10,974
Tanker	205	502	51	758
Dry Cargo Tow	0	0	9,044	9,044
Tanker Tow	48	0	3,753	3,800
Tug/Tow Boat	0	0	(4,467)	(4,467)
Subzone Total:	668	2,085	32,899	35,652
Subzone : 2003F				
Passenger	0	4	18,271	18,276
Dry Cargo	415	1,579	8,980	10,974
Tanker	205	502	51	758
Dry Cargo Tow	0	0	9,044	9,044
Tanker Tow	48	0	3,753	3,800
Tug/Tow Boat	0	0	(4,467)	(4,467)
Subzone Total:	668	2,085	35,632	38,385

Note: Sum of all vessel transits within each study subzone.

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Appendix T ZONE 20 Wilmington, NC

TABLE 6.4 Forecast 2010
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 2001A				
Passenger	0	5	0	5
Dry Cargo	513	1,933	10,007	12,453
Tanker	222	539	56	817
Dry Cargo Tow	0	0	9,985	9,985
Tanker Tow	52	0	4,053	4,104
Tug/Tow Boat	0	0	(4,839)	(4,839)
Subzone Total:	787	2,477	19,262	22,525
Subzone : 2002E				
Passenger	0	5	15,994	15,998
Dry Cargo	513	1,933	10,007	12,453
Tanker	222	539	56	817
Dry Cargo Tow	0	0	9,985	9,985
Tanker Tow	52	0	4,053	4,104
Tug/Tow Boat	0	0	(4,839)	(4,839)
Subzone Total:	787	2,477	35,256	38,519
Subzone : 2003F				
Passenger	0	5	18,807	18,812
Dry Cargo	513	1,933	10,007	12,453
Tanker	222	539	56	817
Dry Cargo Tow	0	0	9,985	9,985
Tanker Tow	52	0	4,053	4,104
Tug/Tow Boat	0	0	(4,839)	(4,839)
Subzone Total:	787	2,477	38,069	41,332

Note: Sum of all vessel transits within each study subzone.

Appendix T ZONE 20 Wilmington, NC

TABLE 6.5 Forecast 1995 - 2010 Vessel Transits by Vessel Type and Size

Vessel Type	Large	Medium	Small	Total
1995 FORECASTED ZONE TOTALS				
Passenger	0	4	17,168	17,172
Dry Cargo	258	1,003	7,252	8,513
Tanker	176	435	44	655
Dry Cargo Tow	0	0	3,967	3,967
Tanker Tow	41	0	2,212	2,253
Tug/Tow Boat	0	0	686	686
1995 Zone Total:	475	1,442	31,328	33,244
2000 FORECASTED ZONE TOTALS				
Passenger	0	4	17,751	17,755
Dry Cargo	300	1,157	8,066	9,523
Tanker	190	467	48	705
Dry Cargo Tow	0	0	4,375	4,375
Tanker Tow	44	0	2,387	2,431
Tug/Tow Boat	0	0	793	793
2000 Zone Total:	534	1,628	33,420	35,581
2005 FORECASTED ZONE TOTALS				
Passenger	0	4	18,271	18,276
Dry Cargo	367	1,375	8,980	10,722
Tanker	205	502	51	758
Dry Cargo Tow	0	0	4,826	4,826
Tanker Tow	48	0	2,577	2,625
Tug/Tow Boat	0	0	927	927
2005 Zone Total:	620	1,881	35,632	38,133
2010 FORECASTED ZONE TOTALS				
Passenger	0	5	18,807	18,812
Dry Cargo	454	1,684	10,007	12,145
Tanker	222	539	56	817
Dry Cargo Tow	0	0	5,326	5,326
Tanker Tow	52	0	2,781	2,833
Tug/Tow Boat	0	0	1,093	1,093
2010 Zone Total:	728	2,228	38,069	41,024

Note: Sum of all arrivals/departures to/from all terminals within the study zone.

TABLE 7 Vessel Casualty History (10 Year Totals) by Subzone, Vessel Type and Size, and Casualty Type

Vessel Type	Size	Collisions	Rammings	Groundings	Other	Total
Subzone: 2003F						
Passenger	Small	0	0	2	0	2
Dry Cargo	Medium	0	0	1	0	1
Tanker	Large	0	0	2	0	2
Tug/Tow Boat	Small	0	0	1	0	1
Subzone Totals:		0	0	6	0	6
Zone Totals:		0	0	6	0	6

Note: OTHER equals barge breakaways and weather caused vessel casualties.

APPENDIX TABLE T-8 ZONE 20, WILMINGTON, NC - VTS LEVELS IN OPERATION

(Not Applicable to This Sub-Zone.)

APPENDIX TABLE T-9 ZONE 20 WILMINGTON, NC
CANDIDATE VTS DESIGN - 1995-2010

UNITS

1	Radar Module 1	- Average Performance
0	Radar Module 2	- Average Performance
1	Radar Module 3	- High Performance
0	Radar Module 4	- High Performance
0	Radar Module 5	- Special Purpose
0	Radar Module 6	- Special Purpose
0	ADS Module 7	- Active Radar Transponder (Type 1)
0	ADS Module 8	- Positional Transponder, Small Area, Very High Accuracy (Type 5)
0	ADS Module 9	- Positional Transponder, Small Area, High Accuracy (Type 6)
3	VHF Module 10	- Low power VHF Transmitting/ Receiving Facility
2	VHF Module 11	- High power VHF Transmitting/ Receiving Facility
1	Meteorological Module 12	- Air temperature, wind direction and speed
1	Meteorological Module 13	- Air temperature, wind direction and speed, visibility
0	Hydrological Module 14	- Water Temperature and Depth
0	Hydrological Module 15	- Water Temperature, Depth and Current
0	VHF/DF MODULE 16	- Line of position measurement to 2 degree RMS
0	CCTV MODULE 17	- Fixed Focus CCTV via Telephone Lines
0	CCTV MODULE 18	- Remotely Controllable CCTV via

TABLE 10A

Avoided Vessel Casualties 1996 - 2010
Candidate VTS Systems

7/31/91

Counts

Vessel Type	Size	Collision	Ramming	Grounding	Total
Passenger	Medium	.01	0.00	.01	.01
Passenger	Small	.45	.06	.36	.88
Dry Cargo	Large	.25	.04	.26	.55
Dry Cargo	Medium	.38	.05	.13	.56
Dry Cargo	Small	.55	.06	.08	.69
Tanker	Large	.29	.06	.33	.68
Tanker	Medium	.09	.01	.04	.14
Tanker	Small	.00	0.00	.00	.01
Dry Cargo Barge T	Small	1.22	.35	.40	1.97
Tanker Barge Tow	Large	.02	.01	.01	.04
Tanker Barge Tow	Small	.74	.12	.41	1.27
Tug/Tow Boat	Small	.01	.00	.01	.02
		4.00	.77	2.04	6.82

Undiscounted Total Dollar Losses (1,000)

Vessel Type	Size	Collision	Ramming	Grounding	Total
Passenger	Medium	13	0	7	20
Passenger	Small	405	58	230	693
Dry Cargo	Large	352	70	83	504
Dry Cargo	Medium	571	105	38	714
Dry Cargo	Small	390	44	50	484
Tanker	Large	740	169	404	1,313
Tanker	Medium	159	15	25	200
Tanker	Small	3	0	1	4
Dry Cargo Barge T	Small	68	52	6	127
Tanker Barge Tow	Large	133	57	46	236
Tanker Barge Tow	Small	2,048	352	200	2,601
Tug/Tow Boat	Small	1	0	0	2
		4,883	923	1,091	6,897

Note: In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 11 Avoided Fatalities 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Medium	.00	0.00	.00	.00
Passenger	Small	.03	.00	.02	.06
Dry Cargo	Large	.03	.00	.03	.07
Dry Cargo	Medium	.05	.01	.02	.07
Dry Cargo	Small	.04	.00	.01	.04
Tanker	Small	.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	.00	.00	.00	.00
Tanker Barge Tow	Small	.00	.00	.00	.00
Tug/Tow Boat	Small	.00	.00	.00	.00
Totals		.15	.02	.08	.25
Candidate VTS Design - Dollars					
Passenger	Medium	1,400.96	0.00	1,288.12	2,689.08
Passenger	Small	43,460.32	6,197.83	34,982.30	84,640.45
Dry Cargo	Large	47,055.81	7,246.08	48,952.56	103,254.45
Dry Cargo	Medium	70,662.24	10,306.88	23,623.73	104,592.85
Dry Cargo	Small	52,959.78	5,750.10	7,563.19	66,273.07
Tanker	Small	12.79	0.00	8.21	21.00
Dry Cargo Barge Tow	Small	4,026.85	1,164.08	1,318.32	6,509.24
Tanker Barge Tow	Small	2,447.04	408.25	1,345.85	4,201.14
Tug/Tow Boat	Small	32.46	10.52	19.50	62.48
Totals		222,058.24	31,083.75	119,101.78	372,243.76

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 12 Avoided Human Injuries 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Medium	.00	0.00	.00	.00
Passenger	Small	.34	.05	.28	.67
Dry Cargo	Large	.00	.00	.00	.01
Dry Cargo	Medium	.01	.00	.00	.01
Dry Cargo	Small	.42	.05	.06	.52
Tanker	Small	.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	.03	.01	.01	.05
Tanker Barge Tow	Small	.02	.00	.01	.03
Tug/Tow Boat	Small	.00	.00	.00	.00
Totals		.82	.11	.36	1.29
Candidate VTS Design - Dollars					
Passenger	Medium	24.05	0.00	22.12	46.17
Passenger	Small	81,836.50	11,670.62	65,872.26	159,379.38
Dry Cargo	Large	807.94	124.41	840.50	1,772.85
Dry Cargo	Medium	1,213.25	176.97	405.61	1,795.83
Dry Cargo	Small	99,724.14	10,827.54	14,241.61	124,793.29
Tanker	Small	22.34	0.00	14.35	36.69
Dry Cargo Barge Tow	Small	7,036.16	2,034.01	2,303.51	11,373.68
Tanker Barge Tow	Small	4,275.74	713.35	2,351.63	7,340.71
Tug/Tow Boat	Small	56.71	18.39	34.07	109.17
Totals		194,996.85	25,565.27	86,085.66	306,647.78

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 13 Avoided Vessels Damaged 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Medium	.01	0.00	.00	.01
Passenger	Small	.39	.04	.11	.54
Dry Cargo	Large	.19	.03	.03	.24
Dry Cargo	Medium	.28	.04	.01	.33
Dry Cargo	Small	.47	.04	.04	.56
Tanker	Large	.22	.05	.04	.31
Tanker	Medium	.07	.01	.01	.08
Tanker	Small	.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	.93	.15	.06	1.13
Tanker Barge Tow	Large	.02	.00	.00	.02
Tanker Barge Tow	Small	.56	.05	.06	.67
Tug/Tow Boat	Small	.00	.00	.00	.00
Totals		3.13	.41	.36	3.90
Candidate VTS Design - Dollars					
Passenger	Medium	4,819.65	0.00	2,573.08	7,392.74
Passenger	Small	131,484.00	14,655.89	58,642.27	204,782.16
Dry Cargo	Large	136,770.46	20,155.46	15,074.91	172,000.82
Dry Cargo	Medium	248,125.30	34,635.49	5,439.08	288,199.87
Dry Cargo	Small	89,724.03	7,921.37	10,592.16	108,237.56
Tanker	Large	171,096.48	38,098.52	94,405.57	303,600.57
Tanker	Medium	43,667.15	3,942.41	10,582.95	58,192.51
Tanker	Small	253.43	0.00	212.30	465.73
Dry Cargo Barge Tow	Small	53,969.83	8,638.92	2,821.08	65,429.84
Tanker Barge Tow	Large	2,910.98	680.00	431.02	4,021.99
Tanker Barge Tow	Small	40,067.86	3,701.49	5,116.56	48,885.91
Tug/Tow Boat	Small	123.84	25.79	72.34	221.97
Totals		923,013.01	132,455.34	205,963.32	1,261,431.67

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 14 Avoided Cargo Damage/Loss 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Medium	.00	0.00	.00	.00
Passenger	Small	.09	.01	.03	.14
Dry Cargo	Large	.07	.01	.02	.10
Dry Cargo	Medium	.10	.02	.01	.13
Dry Cargo	Small	.18	.02	.02	.21
Tanker	Large	.08	.02	.03	.13
Tanker	Medium	.02	.00	.00	.03
Tanker	Small	.00	0.00	.00	.00
Dry Cargo Tow	Small	.17	.05	.02	.24
Tanker Tow	Large	.00	.00	.00	.00
Tanker Tow	Small	.10	.02	.02	.14
Tug/Tow Boat	Small	.00	.00	.00	.00
Totals		.82	.15	.17	1.13
Candidate VTS Design - Dollars					
Passenger	Medium	21.20	0.00	8.01	29.21
Passenger	Small	332.51	37.06	132.44	502.01
Dry Cargo	Large	704.17	153.63	69.27	927.07
Dry Cargo	Medium	1,057.43	218.52	33.43	1,309.38
Dry Cargo	Small	407.19	35.95	47.55	490.69
Tanker	Large	2,445.93	524.40	1,913.02	4,883.35
Tanker	Medium	350.68	31.15	65.28	447.12
Tanker	Small	3.84	0.00	1.45	5.29
Tanker Tow	Large	720.18	305.90	377.94	1,404.03
Tanker Tow	Small	27,861.63	4,648.30	6,241.53	38,751.46
Tug/Tow Boat	Small	1.49	.31	.85	2.65
Totals		33,906.26	5,955.22	8,890.77	48,752.25

Note1: Dollar values include bulk petroleum and chemical cargos only and all vessel fuels spilled. Dollar values exclude cargo loss/damage for non-tank vessel types.

Note2: In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 15 Avoided NavAid Damage 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Small	0.00	.01	.00	.01
Dry Cargo	Large	0.00	.00	.00	.01
Dry Cargo	Medium	0.00	.01	.00	.01
Dry Cargo	Small	0.00	.01	.00	.01
Tanker	Large	0.00	.01	.00	.01
Tanker	Medium	0.00	.00	.00	.00
Tanker	Small	0.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	0.00	.04	.00	.04
Tanker Barge Tow	Large	0.00	.00	.00	.00
Tanker Barge Tow	Small	0.00	.01	.00	.02
Tug/Tow Boat	Small	0.00	.00	.00	.00
Totals		0.00	.09	.01	.10
Candidate VTS Design - Dollars					
Passenger	Small	0.00	41.67	11.77	53.44
Dry Cargo	Large	0.00	24.87	8.41	33.28
Dry Cargo	Medium	0.00	35.37	4.06	39.43
Dry Cargo	Small	0.00	38.66	2.55	41.20
Tanker	Large	0.00	39.11	10.81	49.92
Tanker	Medium	0.00	4.81	1.45	6.26
Tanker	Small	0.00	0.00	.08	.08
Dry Cargo Barge Tow	Small	0.00	227.33	12.89	240.22
Tanker Barge Tow	Large	0.00	5.39	.35	5.74
Tanker Barge Tow	Small	0.00	79.73	13.16	92.88
Tug/Tow Boat	Small	0.00	2.05	.19	2.25
Totals		0.00	498.98	65.71	564.69

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 16 Avoided Bridge Damage 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Small	.00	.00	0.00	.00
Dry Cargo	Large	0.00	.00	0.00	.00
Dry Cargo	Medium	0.00	.00	0.00	.00
Dry Cargo	Small	.00	.00	0.00	.00
Tanker	Large	0.00	.00	0.00	.00
Tanker	Medium	0.00	.00	0.00	.00
Tanker	Small	.00	0.00	0.00	.00
Dry Cargo Barge Tow	Small	.00	.02	0.00	.02
Tanker Barge Tow	Large	0.00	.00	0.00	.00
Tanker Barge Tow	Small	.00	.01	0.00	.01
Tug/Tow Boat	Small	.00	.00	0.00	.00
Totals		.00	.05	0.00	.05
Candidate VTS Design - Dollars					
Passenger	Small	1,259.24	8,074.57	0.00	9,333.81
Dry Cargo	Large	0.00	5,947.29	0.00	5,947.29
Dry Cargo	Medium	0.00	8,459.47	0.00	8,459.47
Dry Cargo	Small	1,391.12	6,790.17	0.00	8,181.29
Tanker	Large	0.00	9,354.34	0.00	9,354.34
Tanker	Medium	0.00	1,149.62	0.00	1,149.62
Tanker	Small	7.10	0.00	0.00	7.10
Dry Cargo Barge Tow	Small	3,072.47	39,929.21	0.00	43,001.68
Tanker Barge Tow	Large	0.00	1,288.71	0.00	1,288.71
Tanker Barge Tow	Small	1,867.08	14,003.55	0.00	15,870.63
Tug/Tow Boat	Small	18.20	265.13	0.00	283.33
Totals		7,615.20	95,262.07	0.00	102,877.27

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

Appendix T Zone 20 Wilmington, NC
TABLE 17 Avoided Hazardous Commodity Spills 1996 - 2010 7/30/91

Commodity	Catastrophic	Large	Medium	Small	Total
Candidate Vts Design - Counts					
KEROSENE	.00	.00	.00	.00	.00
DISTILLATE FUEL OIL	.00	.00	.00	.24	.25
GASOLINE, INCL NATURAL	.00	.00	.00	.00	.01
JET FUEL	.00	.00	.01	0.00	.01
ALCOHOLS	.00	.01	.02	.02	.04
RESIDUAL FUEL OIL	.00	.01	.10	.18	.29
SULPHUR, LIQUID	0.00	.01	.03	0.00	.05
	.00	.04	.17	.44	.65

Note: In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

Appendix T Zone 20 Wilmington, NC
TABLE 18A Annual Benefit & Cost Streams 7/31/91
Candidate VTS Systems

Discounted to 1993

Year	Investment ($1,000)	Operation & Maintenance ($1,000)	Benefits ($1,000)
1993	4,492	0	0
1996	0	370	320
1997	0	336	296
1998	0	306	273
1999	0	278	254
2000	0	253	233
2001	0	230	216
2002	0	209	200
2003	0	190	185
2004	0	173	171
2005	0	157	159
2006	0	143	147
2007	0	130	137
2008	0	118	127
2009	0	107	116
2010	0	97	104
	4,492	3,094	2,939

Undiscounted

Year	Investment ($1,000)	Operation & Maintenance ($1,000)	Benefits ($1,000)
1993	4,492	0	0
1996	0	470	406
1997	0	470	413
1998	0	470	420
1999	0	470	430
2000	0	470	434
2001	0	470	442
2002	0	470	451
2003	0	470	459
2004	0	470	467
2005	0	470	476
2006	0	470	485
2007	0	470	495
2008	0	470	505
2009	0	470	511
2010	0	470	503
	4,492	7,048	6,897

APPENDIX T

ZONE 20 - WILMINGTON, NC

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Wilmington Port & Subzone	Species Category	(Port 20) Species Code	Species Name	Wildlife Abundance Tables Fish & Shellfish Grams per Square Meter Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
2001	102	1	Alewife	.0010	.0010	.0010	.0010
2001	102	3	Menhaden	3.7000	1.0000	3.7000	10.1000
2001	102	5	Butterfish	.0465	.0013	.0013	.0465
2001	102	32	King Mackerel	.3300	.3300	.3300	.3300
2001	102	33	Mackerel	.0016	.0006	.0006	.0016
2001	102	42	Atl. Thread Herring	.0065	.0051	.0100	.0023
2001	102	43	Cuban Anchovy	.0062	0.0000	.0062	.0062
2001	102	43	Dusty Anchovy	.0010	0.0000	.0010	.0010
2001	102	43	Flat Anchovy	0.0000	.0028	.0980	0.0000
2001	102	43	Striped Anchovy	.0111	0.0000	.0111	.0111
2001	102	44	Striped Mullet	.1200	.1200	.1200	.1200
2001	102	72	Spanish Sardine	.0008	.0273	.0273	.0008
2001	102	128	Sea Robin	.0402	.0255	.0003	0.0000
2001	102	130	Orange Filefish	.0700	.0336	.0336	.0700
2001	103	8	Bluefish	.9600	0.0000	.9600	1.7100
2001	103	11	Weakfish	4.6707	4.6707	4.6707	4.6707
2001	103	50	Bonito	.0360	.0360	.0360	.0360
2001	103	51	Crevalle Jack	.0130	.0130	.0130	.0130
2001	103	52	Orange Amberjack	.0530	.0530	.0530	.0530
2001	103	54	Blue Runner	.0130	.0130	.0130	.0130
2001	104	12	Tuna	.0110	.0110	.0110	0.0000
2001	104	13	Swordfish	.0520	.0520	.0520	.0520
2001	104	14	Shark	.0383	.0383	.0383	.0383
2001	104	15	Dogfish	.0074	.0074	.0074	.0074
2001	105	17	Summer Flounder	.0180	.0180	.0180	.0180
2001	105	56	Southern Flounder	.0068	.0068	.0068	.0068
2001	105	251	Dusky Flounder	.0130	.0140	0.0000	0.0000
2001	105	251	Windowpane	.0205	.0155	.0117	.0015
2001	106	28	Tilefish	.0750	.0750	.0750	.0750
2001	106	35	Atlantic Croaker	.0150	.0150	.0150	.0150
2001	106	36	Banded Drum	.0347	.0933	.0121	.0013
2001	106	36	Star Drum	.0125	.0290	.0467	.0177
2001	106	37	Spot	.0220	.0220	.0220	.0220
2001	106	40	Eel	.0011	.0011	.0011	.0011
2001	106	46	Spotted Sea Trout	.0420	.0420	.0420	.0420
2001	106	48	Salt Catfish	0.0000	.0120	.0120	0.0000
2001	106	58	Red Drum	.0014	.0014	.0014	.0014
2001	106	59	Black Drum	.0130	.0130	.0130	.0130
2001	106	60	Porgy	.0080	.0080	.0080	.0080
2001	106	60	Porgy	.0389	.0850	.0850	.0389
2001	106	61	Florida Pompano	.0130	.0130	.0130	.0130
2001	106	62	Grunt	.0220	.0220	.0220	.0220
2001	106	63	Pinfish	.0076	.0076	.0076	.0076
2001	106	64	Kingfish	.0056	.0056	.0056	.0056
2001	106	64	Kingfish	.0082	.0136	.0082	.0027
2001	106	68	Showy Grouper	0.0000	.0089	.0089	0.0000
2001	106	71	Spotted Hake	.0160	.0160	.0160	.0160
2001	106	91	Sand Perch	.0120	.0263	.0263	.0120
2001	106	116	Skate	.0206	.0058	.0058	.0206
2001	106	116	Stingrays	.6386	.0420	.0420	.6386
2001	106	116	Stingrays	.6386	.0420	.0420	.6386
2001	106	131	Round Scad	.0073	.0439	.0436	.0073
2001	106	134	Inshore Lizardfish	.0139	.0139	.0139	.0139

APPENDIX T

ZONE 20 - WILMINGTON, NC (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Wilmington Port & Subzone	Species Category	(Port 20) Species Code	Species Name	Wildlife Abundance Tables Fish & Shellfish Grams per Square Meter Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
2001	106	142	Southern Killifish	.0060	.0060	.0060	.0060
2001	106	199	Ariomma Bondi	.0028	0.0000	.0028	.0028
2001	106	199	Cobia	.0170	.0061	.0061	.0170
2001	106	199	Roundfish	.0329	.0025	.0025	.0329
2001	106	199	Sharksucker	.0018	.0005	.0005	.0018
2001	106	199	Synodus Foeteus	.0130	.0257	.0257	.0130
2001	106	239	Atlantic Bumper	0.0000	.0980	.0980	0.0000
2001	107	216	Scallop	.0620	.0620	.0620	.0620
2001	107	299	Mollusc	.0120	.0120	.0120	.0120
2001	108	215	Shrimp	.0840	.0840	.0840	.0840
2001	108	217	Crab	.0006	.0006	.0006	.0006
2001	108	298	Decapod, Stomapod	.2001	.2830	.1910	.0879
2001	109	207	Blue Crab	.0080	.0080	.0080	.0080
2002	102	1	Alewife	.0010	.0010	.0010	.0010
2002	102	3	Menhaden	3.7000	1.0000	3.7000	10.1000
2002	102	5	Butterfish	.0465	.0013	.0013	.0465
2002	102	32	King Mackerel	.3300	.3300	.3300	.3300
2002	102	33	Mackerel	.0016	.0006	.0006	.0016
2002	102	42	Atl. Thread Herring	.0065	.0051	.0100	.0023
2002	102	43	Cuban Anchovy	.0062	0.0000	.0062	.0062
2002	102	43	Dusty Anchovy	.0010	0.0000	.0010	.0010
2002	102	43	Flat Anchovy	0.0000	.0028	.0980	0.0000
2002	102	43	Striped Anchovy	.0111	0.0000	.0111	.0111
2002	102	44	Striped Mullet	.1200	.1200	.1200	.1200
2002	102	72	Spanish Sardine	.0008	.0273	.0273	.0008
2002	102	128	Sea Robin	.0402	.0255	.0003	0.0000
2002	102	130	Orange Filefish	.0700	.0336	.0336	.0700
2002	103	8	Bluefish	.9600	0.0000	.9600	1.7100
2002	103	11	Weakfish	4.6707	4.6707	4.6707	4.6707
2002	103	50	Bonito	.0360	.0360	.0360	.0360
2002	103	51	Crevalle Jack	.0130	.0130	.0130	.0130
2002	103	52	Orange Amberjack	.0530	.0530	.0530	.0530
2002	103	54	Blue Runner	.0130	.0130	.0130	.0130
2002	104	12	Tuna	.0110	.0110	.0110	0.0000
2002	104	13	Swordfish	.0520	.0520	.0520	.0520
2002	104	14	Shark	.0383	.0383	.0383	.0383
2002	104	15	Dogfish	.0074	.0074	.0074	.0074
2002	105	17	Summer Flounder	.0180	.0180	.0180	.0180
2002	105	56	Southern Flounder	.0068	.0068	.0068	.0068
2002	105	251	Dusky Flounder	.0130	.0140	0.0000	0.0000
2002	105	251	Windowpane	.0205	.0155	.0117	.0015
2002	106	28	Tilefish	.0750	.0750	.0750	.0750
2002	106	35	Atlantic Croaker	.0150	.0150	.0150	.0150
2002	106	36	Banded Drum	.0347	.0933	.0121	.0013
2002	106	36	Star Drum	.0125	.0290	.0467	.0177
2002	106	37	Spot	.0220	.0220	.0220	.0220
2002	106	40	Eel	.0011	.0011	.0011	.0011
2002	106	46	Spotted Sea Trout	.0420	.0420	.0420	.0420
2002	106	48	Salt Catfish	0.0000	.0120	.0120	0.0000
2002	106	58	Red Drum	.0014	.0014	.0014	.0014
2002	106	59	Black Drum	.0130	.0130	.0130	.0130
2002	106	60	Porgy	.0080	.0080	.0080	.0080
2002	106	60	Porgy	.0389	.0850	.0850	.0389

ZONE 20 - WILMINGTON, NC (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Wilmington Port & Subzone	Species Category	(Port 20) Species Code	Species Name	Wildlife Abundance Tables Fish & Shellfish Grams per Square Meter Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
2002	106	61	Florida Pompano	.0130	.0130	.0130	.0130
2002	106	62	Grunt	.0220	.0220	.0220	.0220
2002	106	63	Pinfish	.0076	.0076	.0076	.0076
2002	106	64	Kingfish	.0056	.0056	.0056	.0056
2002	106	64	Kingfish	.0082	.0136	.0082	.0027
2002	106	68	Showy Grouper	0.0000	.0089	.0089	0.0000
2002	106	71	Spotted Hake	.0160	.0160	.0160	.0160
2002	106	91	Sand Perch	.0120	.0263	.0263	.0120
2002	106	116	Skate	.0206	.0058	.0058	.0206
2002	106	116	Stingrays	.6386	.0420	.0420	.6386
2002	106	116	Stingrays	.6386	.0420	.0420	.6386
2002	106	131	Round Scad	.0073	.0439	.0436	.0073
2002	106	134	Inshore Lizardfish	.0139	.0139	.0139	.0139
2002	106	142	Southern Killifish	.0060	.0060	.0060	.0060
2002	106	199	Ariomma Bondi	.0028	0.0000	.0028	.0028
2002	106	199	Cobia	.0170	.0061	.0061	.0170
2002	106	199	Roundfish	.0329	.0025	.0025	.0329
2002	106	199	Sharksucker	.0018	.0005	.0005	.0018
2002	106	199	Synodus Foeteus	.0130	.0257	.0257	.0130
2002	106	239	Atlantic Bumper	0.0000	.0980	.0980	0.0000
2002	107	216	Scallop	.0620	.0620	.0620	.0620
2002	107	299	Mollusc	.0120	.0120	.0120	.0120
2002	108	215	Shrimp	.0840	.0840	.0840	.0840
2002	108	217	Crab	.0006	.0006	.0006	.0006
2002	108	298	Decapod, Stomapod	.2001	.2830	.1910	.0879
2002	109	207	Blue Crab	.0080	.0080	.0080	.0080
2003	101	1	American Shad	.4800	.2400	0.0000	.2400
2003	102	3	Menhaden	.1800	.1500	.1500	.1700
2003	102	5	Butterfish	0.0000	0.0000	.0060	.0030
2003	102	33	Spanish Mackerel	0.0000	.0230	.0090	.0050
2003	102	42	Atl. Thread Herring	0.0000	.0410	.1300	.0700
2003	102	43	Anchovy	0.0000	.0300	.0600	.0300
2003	103	8	Bluefish	0.0000	.0070	.0040	.0020
2003	103	9	Striped Bass	.1000	.1900	.1900	.1900
2003	105	17	Summer Flounder	.1500	.9500	.8200	.8800
2003	106	35	Atlantic Croaker	3.5000	3.5000	3.5000	3.5000
2003	106	36	Drum	0.0000	0.0000	.0015	.0018
2003	106	37	Spot	1.3000	1.3000	1.3000	1.3000
2003	106	46	Spotted Sea Trout	1.2000	1.3000	1.5000	1.2000
2003	106	48	Sea Catfish	.0580	.1800	0.0000	.0300
2003	106	142	Killifish	7.6000	7.6000	3.2500	.1200
2003	106	142	Mummichog	6.0000	6.0000	.5000	.5000
2003	107	212	Oyster	.8800	.8800	.8800	.8800
2003	107	213	Hard Clam	.0090	.0090	.0090	.0090
2003	108	209	Blue Crab	10.8000	10.8000	10.8000	10.8000
2003	108	215	Shrimp	1.3000	2.8000	2.4000	1.1000

ZONE 20 - WILMINGTON, NC (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Wilmington Port & Subzone	Species Category	(Port 20) Species Code	Species Name	Wildlife Abundance Tables Fish & Shellfish Larvae Numbers per Square Meter Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
2001	202	1004	Herring	0.0000	0.0000	0.0000	1.1900
2001	202	1007	Mackerel	2.7500	1.0000	0.0000	0.0000
2001	202	1128	Sea Robin	0.0000	.2000	.2000	0.0000
2001	202	1199	Larvae	21.0000	10.0000	1.0000	21.0000
2001	203	1008	Bluefish	.0925	.0500	0.0000	0.0000
2001	203	1053	Jack	2.7500	.0092	0.0000	.0092
2001	204	1012	Bluefin Tuna	.3830	.3830	.3830	.3830
2001	205	1199	Larvae	.5000	1.0000	.1000	1.0000
2001	205	1251	Lefteye Flounder	2.0160	1.0000	.1833	.1000
2001	206	1021	Codfish	0.0000	0.0000	0.0000	.0369
2001	206	1036	Drum	0.0000	0.0000	.1667	2.8400
2001	206	1040	American Eel	0.0000	.0705	0.0000	0.0000
2001	206	1076	Sea Bass	1.9250	1.0000	0.0000	0.0000
2001	206	1120	Goby	0.0000	0.0000	0.0000	.1000
2001	206	1199	Lanternfish	0.0000	0.0000	0.0000	.1800
2001	206	1267	Goatfish	.0216	0.0000	0.0000	.0917
2001	207	1199	Larvae	2.0000	20.0000	2.0000	0.0000
2001	208	1199	Larvae	.0016	.0042	0.0000	0.0000
2002	202	1004	Herring	0.0000	0.0000	0.0000	1.1900
2002	202	1007	Mackerel	2.7500	1.0000	0.0000	0.0000
2002	202	1128	Sea Robin	0.0000	.2000	.2000	0.0000
2002	202	1199	Larvae	21.0000	10.0000	1.0000	21.0000
2002	203	1008	Bluefish	.0925	.0500	0.0000	0.0000
2002	203	1053	Jack	2.7500	.0092	0.0000	.0092
2002	204	1012	Bluefin Tuna	.3830	.3830	.3830	.3830
2002	205	1199	Larvae	.5000	1.0000	.1000	1.0000
2002	205	1251	Lefteye Flounder	2.0160	1.0000	.1833	.1000
2002	206	1021	Codfish	0.0000	0.0000	0.0000	.0369
2002	206	1036	Drum	0.0000	0.0000	.1667	2.8400
2002	206	1040	American Eel	0.0000	.0705	0.0000	0.0000
2002	206	1076	Sea Bass	1.9250	1.0000	0.0000	0.0000
2002	206	1120	Goby	0.0000	0.0000	0.0000	.1000
2002	206	1199	Lanternfish	0.0000	0.0000	0.0000	.1800
2002	206	1267	Goatfish	.0216	0.0000	0.0000	.0917
2002	207	1199	Larvae	2.0000	20.0000	2.0000	0.0000
2002	208	1199	Larvae	.0016	.0042	0.0000	0.0000
2003	201	1262	Gizzard Shad	9.8630	0.0000	0.0000	0.0000
2003	202	1003	Atlantic Menhaden	2.5000	1.0000	1.0000	5.0000
2003	202	1199	Larvae	1367.0000	651.0000	65.0000	1367.0000
2003	203	1199	Larvae	12.2000	11.6000	.5800	0.0000
2003	205	1199	Larvae	5.0000	5.8000	.5800	5.8000
2003	206	1199	Larvae	15.4000	23.1000	7.7000	15.4000
2003	207	1199	Larvae	20.0000	200.0000	20.0000	0.0000
2003	208	1199	Larvae	.0160	.0420	0.0000	0.0000

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ZONE 20 - WILMINGTON, NC (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Wilmington Port & Subzone	Species Category	(Port 20) Species Code	Species Name	Wildlife Abundance Tables Birds Numbers per Square Kilometer Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
2001	111	516	Common Loon	.0400	0.0000	.0700	.3500
2001	111	516	Red Throated Loon	.0100	0.0000	0.0000	0.0000
2001	112	571	Shorebirds	35.8000	17.3000	17.3000	158.2000
2001	113	531	Bonaparte's Gull	.0700	0.0000	0.0000	.5700
2001	113	531	Glaucous Gull	0.0000	0.0000	0.0000	.0100
2001	113	531	Gull	0.0000	0.0000	0.0000	.0400
2001	113	531	Herring Gull	.2200	0.0000	.1100	.3200
2001	113	531	Laughing Gull	.2500	.0200	.2700	0.0000
2001	113	532	Black Legged Kittiwake	0.0000	0.0000	0.0000	.1100
2001	113	533	Brown Noody	0.0000	0.0000	.0100	0.0000
2001	113	533	Common Tern	.0300	.0600	2.1800	0.0000
2001	113	533	Forster's Tern	0.0000	0.0000	.0100	0.0000
2001	113	533	Least Tern	0.0000	.0100	0.0000	0.0000
2001	113	533	Razor Bill	0.0000	0.0000	0.0000	.0200
2001	113	533	Royal Tern	.0200	.0200	.0100	10.0000
2001	113	533	Sandwich Tern	0.0000	.0100	.0100	0.0000
2001	113	534	Black Tern	.0100	.0200	.6500	0.0000
2001	113	534	Manx Shearwater	0.0000	0.0000	.0100	.0200
2001	113	534	Shearwater	.0200	.0700	.4600	.1400
2001	113	534	Tern	.0300	.1900	.2100	.0100
2001	113	535	Jaeger	0.0000	0.0000	.0100	0.0000
2001	113	535	Parasitic Jaeger	.0200	0.0000	.0100	0.0000
2001	113	535	Pomarine Jaeger	0.0000	0.0000	.0300	.0200
2001	113	536	Northern Fulmar	0.0000	0.0000	0.0000	.0400
2001	113	542	Phalarope	0.0000	.0100	0.0000	3.2700
2001	113	542	Red Phalarope	0.0000	0.0000	.0200	5.9000
2001	113	542	Red-Necked Phalarope	0.0000	0.0000	.2200	2.2200
2001	113	547	Gannet	.6600	0.0000	0.0000	0.0000
2001	113	599	Other	0.0000	.1900	1.4800	.0300
2002	111	511	Dabbling Duck	245.0000	0.0000	245.0000	490.0000
2002	111	512	Coot, Gallinule	160.0000	0.0000	160.0000	320.0000
2002	111	513	Goose	13.5000	0.0000	13.5000	27.0000
2002	111	514	Swan	27.0000	27.0000	27.0000	27.0000
2002	111	516	Common Loon	.0400	0.0000	.0700	.3500
2002	111	516	Red Throated Loon	.0100	0.0000	0.0000	0.0000
2002	112	571	Shorebirds	35.8000	17.3000	17.3000	158.2000
2002	113	531	Bonaparte's Gull	.0700	0.0000	0.0000	.5700
2002	113	531	Glaucous Gull	0.0000	0.0000	0.0000	.0100
2002	113	531	Gull	0.0000	0.0000	0.0000	.0400
2002	113	531	Herring Gull	.2200	0.0000	.1100	.3200
2002	113	531	Laughing Gull	.2500	.0200	.2700	0.0000
2002	113	532	Black Legged Kittiwake	0.0000	0.0000	0.0000	.1100
2002	113	533	Brown Noody	0.0000	0.0000	.0100	0.0000
2002	113	533	Common Tern	.0300	.0600	2.1800	0.0000
2002	113	533	Forster's Tern	0.0000	0.0000	.0100	0.0000
2002	113	533	Least Tern	0.0000	.0100	0.0000	0.0000
2002	113	533	Razor Bill	0.0000	0.0000	0.0000	.0200
2002	113	533	Royal Tern	.0200	.0200	.0100	10.0000
2002	113	533	Sandwich Tern	0.0000	.0100	.0100	0.0000
2002	113	534	Black Tern	.0100	.0200	.6500	0.0000
2002	113	534	Manx Shearwater	0.0000	0.0000	.0100	.0200
2002	113	534	Shearwater	.0200	.0700	.4600	.1400
2002	113	534	Tern	.0300	.1900	.2100	.0100
2002	113	535	Jaeger	0.0000	0.0000	.0100	0.0000
2002	113	535	Parasitic Jaeger	.0200	0.0000	.0100	0.0000

ZONE 20 - WILMINGTON, NC (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Wilmington Port & Subzone	Species Category	(Port 20) Species Code	Species Name	Wildlife Abundance Tables Birds Numbers per Square Kilometer Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
2002	113	535	Pomarine Jaeger	0.0000	0.0000	.0300	.0200
2002	113	536	Northern Fulmar	0.0000	0.0000	0.0000	.0400
2002	113	542	Phalarope	0.0000	.0100	0.0000	3.2700
2002	113	542	Red Phalarope	0.0000	0.0000	.0200	5.9000
2002	113	542	Red-Necked Phalarope	0.0000	0.0000	.2200	2.2200
2002	113	547	Gannet	.6600	0.0000	0.0000	0.0000
2002	113	599	Other	0.0000	.1900	1.4800	.0300
2003	111	511	Dabbling Duck	245.0000	0.0000	245.0000	490.0000
2003	111	512	Coot, Gallinule	160.0000	0.0000	160.0000	320.0000
2003	111	513	Goose	13.5000	0.0000	13.5000	27.0000
2003	111	514	Swan	27.0000	27.0000	27.0000	27.0000
2003	112	561	Black-crowned Night Heron	.5350	.5350	.5350	.5350
2003	112	561	Cattle Egret	.6360	.6360	0.0000	0.0000
2003	112	561	Great Egret	.7120	.7120	.3500	.3500
2003	112	561	Green Heron	.0260	.0260	.0130	.0130
2003	112	561	Little Blue Heron	.4420	.4420	.2210	.0440
2003	112	561	Louisiana Heron	3.1580	3.1580	0.0000	0.0000
2003	112	561	Snowy Egret	2.7890	2.7890	0.0000	0.0000
2003	112	564	Glossy Ibis	.8210	.8210	0.0000	0.0000
2003	112	564	White Ibis	10.1180	10.1180	5.0500	1.0118
2003	113	531	Laughing Gull	3.7800	3.7800	3.7800	0.0000
2003	113	533	Black Skimmer	.1920	.1920	.1920	.1920
2003	113	533	Common Tern	.1350	.1350	.0500	0.0000
2003	113	533	Gull Billed Tern	1.0280	1.0280	.5000	0.0000
2003	113	533	Least Tern	.1510	.1510	.0750	0.0000
2003	113	533	Royal tern	26.3400	26.3400	13.1700	2.6340
2003	113	533	Sandwich Tern	.0930	.0930	.0465	.0093

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JACKSONVILLE, FL

(ZONE 21)

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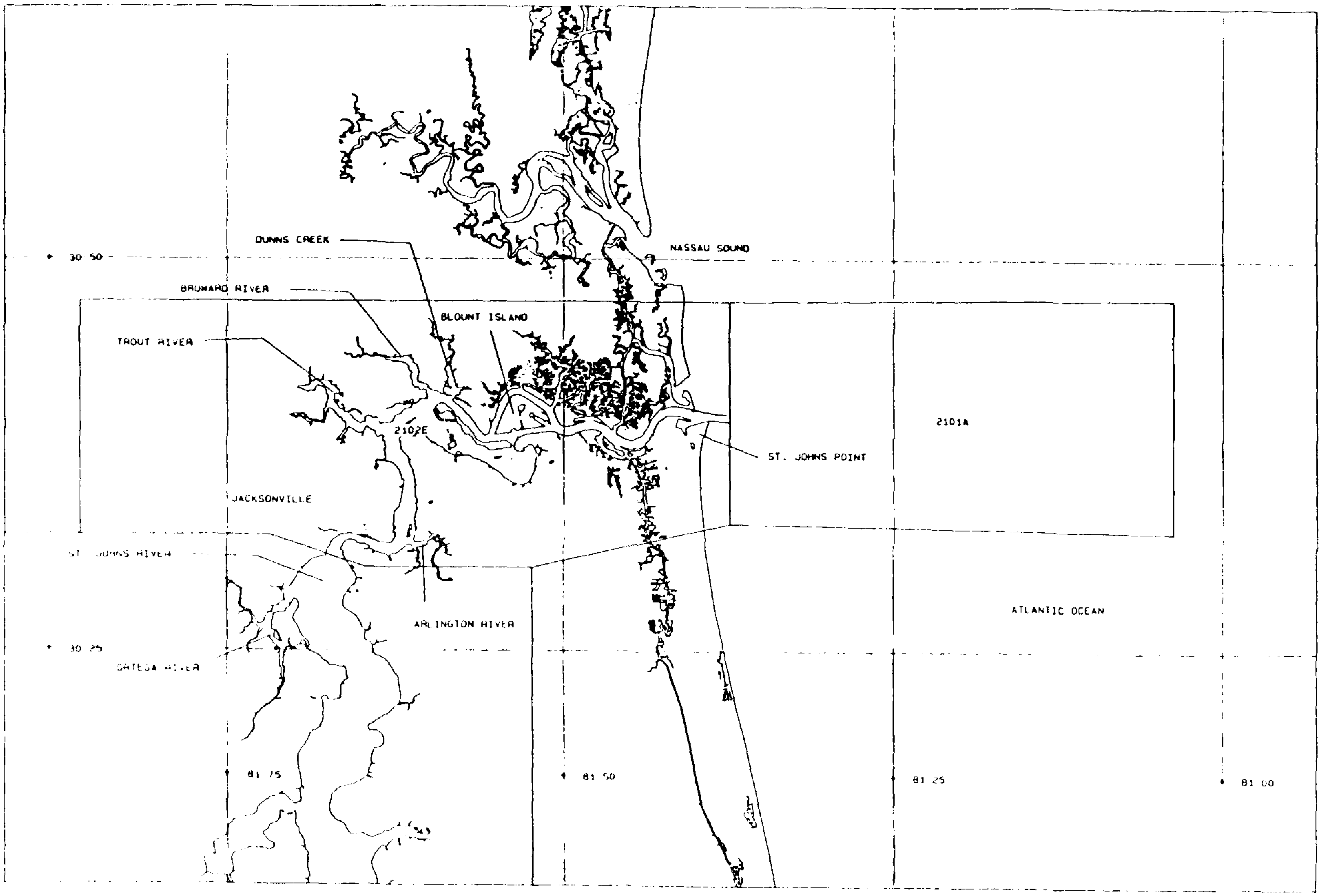
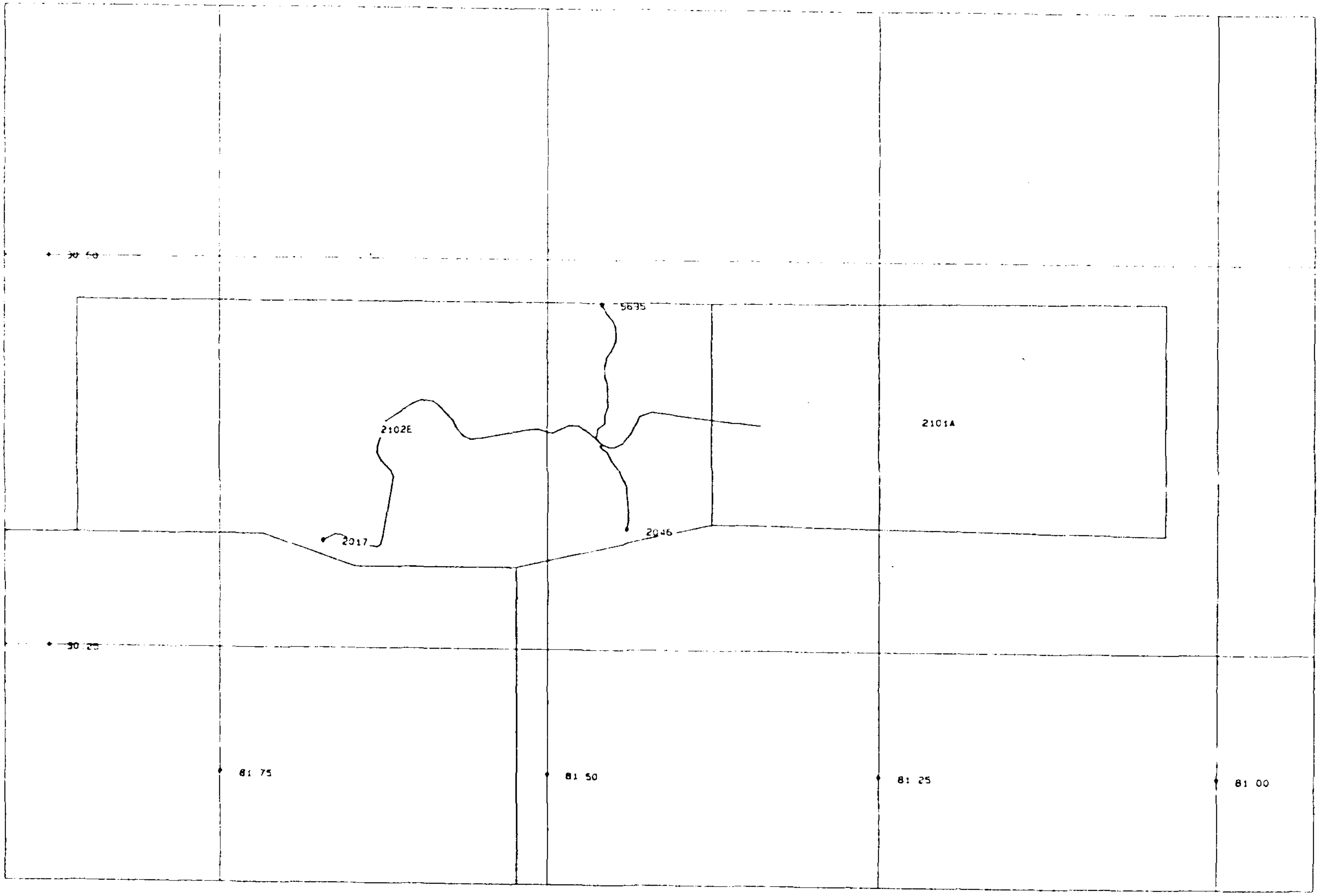
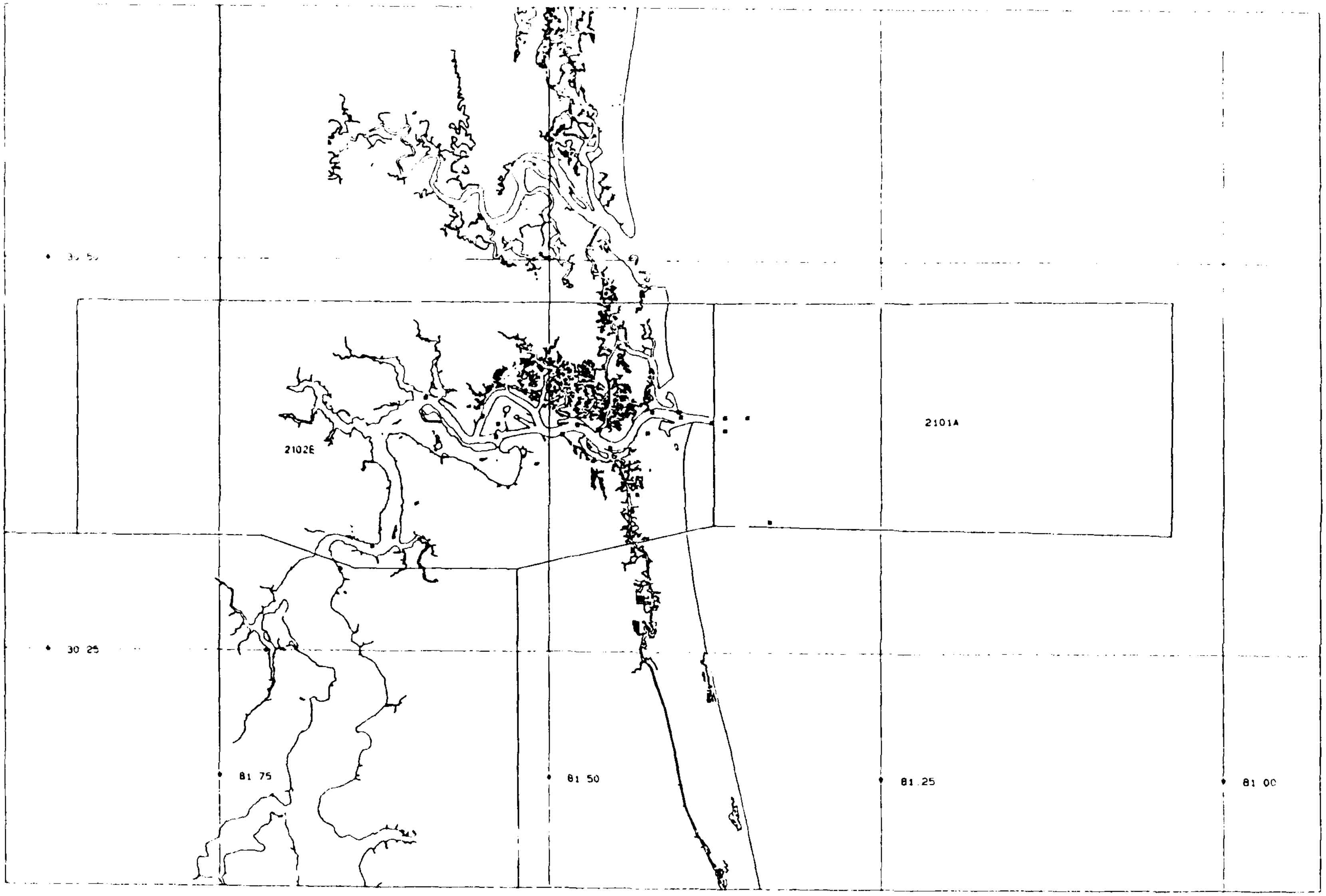
STUDY ZONE MAPS



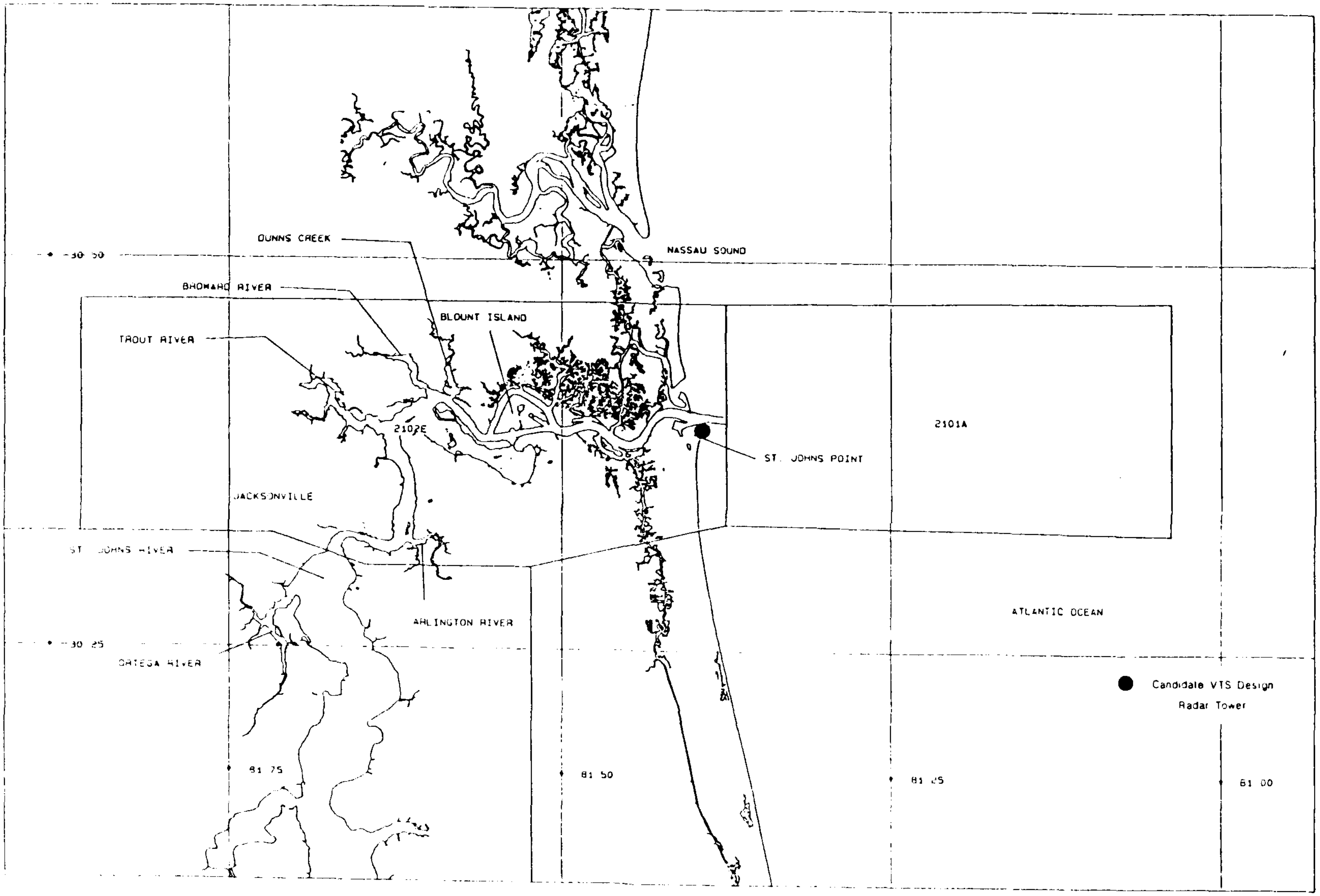
ZONE 21 - JACKSONVILLE, FL - ZONE AND SUBZONE BOUNDARIES



ZONE 21 - JACKSONVILLE, FL - DOMINANT VESSEL ROUTES AND COE WATERWAY CODES



ZONE 21 - JACKSONVILLE, FL - BASE PERIOD (10 YEAR) VESSEL CASUALTIES



ZONE 21 - JACKSONVILLE, FL - CANDIDATE VTS DESIGN RADAR LOCATIONS

CANDIDATE VTS DESIGN REPORT

FOR

JACKSONVILLE, FL

(ZONE 21)

Prepared for:
U.S. Department of Transportation
Research and Special Programs Administration
John A. Volpe National Transportation Systems Center
Cambridge, MA 02142

Prepared by:
NAVCOM Systems, Inc.,
7203 Gateway Court
Manassas, VA 22110

July 1991

OVERVIEW

The Candidate VTS Design described in this appendix is one of 23 developed for all the study zones included in the study. This appendix documents the task performed, under Contract DTRS-57-88-C-00088 Technical Task Directive 13, as an integral part of the total Port Needs Study. The ultimate product of this task effort is an informed preliminary technical assessment of the approximate cost to the Federal Government to implement and operate a state-of-the-art VTS system. This appendix does not contain a comprehensive definition of the VTS operating requirements nor does it propose a final VTS specification suitable for implementation.

In order to consistently estimate the life cycle costs of a VTS system in each of the study zones, a "Candidate VTS Design" has been defined for each study zone using a uniform set of design criteria. Each study zone Candidate VTS Design is a composite of generic modules selected from a master list of 18 state-of-the-art surveillance modules, communications and display technology. Among the surveillance modules in the master list are several levels of technical performance from which the selection is made for application to each study sub-zone to address the local navigational surveillance needs and conditions. The Candidate VTS Design in each study zone represents a consistent application of the surveillance modules at the sub-zone level. The sub-zone surveillance technology is subsequently integrated into a total system for the study zone via state-of-the-art communications and display consoles at the Vessel Traffic Center (VTC) in each zone.

The application of the surveillance modules in each sub-zone responds to the technical requirements of that sub-zone as perceived by the study team. The Candidate VTS Design represents a preliminary engineering judgement on the appropriate level of technology in each sub-zone. The Candidate VTS Design may be considered as an informed judgement made by the contractor study team for the sole purpose of developing cost estimates that are consistent across the 23 study zones and suitable for benefit/cost comparisons among the study zones and initial budget planning and implementation priorities. The approach used to calculate VTS system costs for all 23 study zones is found in Volume III, Technical Supplement.

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PORT OF JACKSONVILLE, FLORIDA VTS DESIGN

1.0 SCOPE

This report includes a port survey and a VTS design for Jacksonville, Florida. The port survey is based on a review of all pertinent literature including navigational charts. The methodology used to produce the VTS design entails coupling the problems identified in the port survey with solutions offered by state-of-the-art technology as identified in the VTS Technology Survey, November 1990. When possible, technological advances which permit manpower reductions are applied. Not all VTS problems are amenable to strictly technological solutions; some require changes in procedures and/or enforcement. These situations are identified where they occur.

2.0 JACKSONVILLE PORT SURVEY

2.1 INTRODUCTION

This survey report is based exclusively upon review of available literature and examination of the charts for the surveyed area and its approaches. The information thus gained has been evaluated and interpreted based upon the Survey Team's experience as professional mariners and in vessel traffic management systems.

The Survey Area includes the Ports of Jacksonville and Mayport, the Saint John River from its entrance to the head of deep-draft navigation at Jacksonville, and the seaward approaches to the Saint Johns River.

Jacksonville lies over twenty miles upstream from the ocean entrance and the intervening channel leaves little room for error in shiphandling. Portions are marked by strong currents and portions of the improved cuts are cut through rock, thus representing a potential can opener for the unwary mariner.

The entire St. Johns River area must be considered environmentally sensitive and, because of the importance of recreational activities to the economy, ecological concerns are more politically important than they might be elsewhere. The volume of petroleum and chemicals moving by water does not rank the port among the U. S. leaders, but is sufficient to pose potential hazards.

2.2 OVERVIEW OF THE PORT

Climate within the Survey Area is much affected by the trade winds. During summer months, the trades result in more moderate temperatures than may be the case farther to the north. During the winter, storms and extreme cold often remains north of the area. The climate may be considered maritime sub-tropical, with considerable variation between Mayport near the entrance to the Saint Johns River and Jacksonville, some 23 miles inland. At the coast the maritime influence moderates extremes, making inland Jacksonville both cooler in winter and warmer in summer than Mayport.

Wind speeds are generally highest during the period September through April, when they exceed 17 knots about 8% of the time. Fog is mainly a winter phenomena, and may be produced by any easterly wind. Fog often remains across the entrance when visibility is good elsewhere on the river. In calm weather, smog generated by paper and fertilizer plants often obscures the channel above Dames Point. Radiation fog, occurring most frequently near Jacksonville, normally burns off by 1200. On average, there are about 30 days per year when visibility drops below 0.5 mile.

The mean range of tide is 4.9 feet at the Saint Johns River entrance, and about 1.2 feet at Jacksonville. Tidal currents are strong within the Saint Johns River as far as Jacksonville, and strong sets may be experienced across the entrance to the jetties. The set may become dangerous in gale-force winds and the buoyage of the entrance channel may be dragged from station. Velocities within the channel between the jetties is about 1.9 knots on the flood and 2.3 knots at maximum ebb. These strong currents are carried to Jacksonville with varying velocity, and are a major factor in ship movement.

Pilotage is compulsory for all foreign vessels and for U. S. vessels under register. Pilotage is optional for U. S.-flag ships in the coastwise trade which have on board a federally licensed pilot.

Pilot service is provided by the Saint Johns Bar Pilots, who maintain a pilot station at Mayport, about three miles inside the entrance. The pilot station monitors VHF-FM Channels 14, 16, and 18A. Communications between the Pilots and ships are established on CH16 and then shift to CH14 as a working channel. Inbound ships are requested to report their Estimated Time of Arrival (ETA) to the pilot station at least two hours in advance, together with their draft. The pilot station should be contacted again one hour before ETA. Pilot boats meet inbound ships and take pilots off outbound traffic between the sea buoy and the outermost entrance channel buoy.

Docking pilots and tugs are available at Jacksonville. The tugs use VHF-FM Channels 7A, 10, 13, 16 and 18A and the docking pilots use Channels 7A, 13 and 16.

A Federal project provides for a 42-40 feet deep channel from the ocean to Saint Johns Point, thence 40-38 feet to a point 1.75 miles north of Commodore Point. From that point to Commodore Point channel depth is 34 feet, and from Commodore Point to the Florida East Coast Railway Bridge at Jacksonville depth reduces to 30 feet.

2.3 EXISTING TRAFFIC MANAGEMENT

2.3.1 Saint Johns River Navigational Guidelines

The channel deepening projects completed in 1978 resulted in deep and steep-sided channel banks cut through rock in some areas, but did not appreciably widen the channels. The resulting condition, coupled with the increasing volume of traffic and size of ships, caused the U. S. Coast Guard (USCG) Captain of the Port (COTP) to develop guidelines to enhance the safe transit of ships constrained to the channels by reason of draft. The "Guidelines" have not been incorporated into the Code of Federal Regulations but are published for the information of mariners in the Coast Pilot (Reference 1). The Coast Pilot should be consulted for details but, in general, the "Guidelines" recommend specific towing practices for tug-barge combinations using the Saint Johns River, suggest a series of reporting points at which all vessels should make security calls on Channel 13 VHF-FM and identify four areas of particular concern or hazard to traffic safety.

The "Guidelines" suggest the following Security Calling locations:

- o Vessels inbound from sea should announce entrance intentions 30 minutes before arrival at the entrance jetties.

- o Tugs intending to make up tows immediately inside the jetties should announce their intentions at least 45 minutes before commencement of operations.

- o Tows preparing to enter the Saint Johns River from the Intracoastal Waterway (ICW) should announce intentions 30 minutes before leaving the ICW.

- o Vessels getting underway from facilities on the river should make security calls advising of their intentions at least 30 minutes in advance of movement.

- o Vessels using the main channel should make security calls 15 minutes before crossing the ICW, arrival at Dames Point, entering Trout River Cut, arrival at Commodore Point.

The areas of particular concern are identified by the "Guidelines" and are discussed below.

- o The junction of the Saint Johns River with the ICW is of particular concern because of the joining of traffic flows, the amount of time that a large tow may require to negotiate the change from river to ICW, or vice versa, and congestion. The seasonal flow of recreational boats north or south through the ICW varies with the season but is quite heavy at times. In addition, there are shoreside facilities along the north side of the river which may necessitate speed reductions to avoid wake damage.

- o The Dames Point turn requires significant alterations in course in an area of strong cross-currents. The currents tend to set ships into the bend under all current conditions except slack water. In addition, the channel in this area is used as a turning basin for vessels serving facilities in the Blount Island area.

- o The Trout River Cut is through rock formations and deep-draft ships must exercise particular care not to stray from the channel in this area. Local knowledge is required to predict current effects and use of tugs by deep-craft ships is encouraged in order to avoid being set onto vessels alongside the oil terminals along the West Bank.

- o The bend at Commodore Point requires about a 90^0 course change, action which is hampered by the bridges and piers nearby.

Low powered vessels and those with poor handling characteristics are advised to be prepared to delay entrance into the river and/or movements by up to 30 minutes to accommodate other shipping.

In order to "prevent problems which might arise from failure to exchange information necessary to safe meeting and passing" the USCG COTP monitors Channel 13.

2.3.2 Anchorage Areas

Special Anchorage Areas have been established in the Saint Johns River by 33CFR110.73. In addition, Naval and Explosives anchorages have been designated in the Atlantic Ocean east of Mayport by 33CFR110.182.

A series of Federal Anchorages have been established by 33CFR183. These are clearly delineated on Chart 11491. Draft, time limits and limits on the purpose of anchoring apply and the Coast Pilot should be consulted for details. There are reports that Anchorage "C", immediately south of Commodore Point, has been rendered unusable by large ships as the result of construction of the Commodore Point Expressway Bridge.

2.3.3 Security Zone

The COTP has established a Security Zone, to be activated as required, at the junction of Brill's Cut Range and Broward Point Turn, centered at 30^0-24'-25"N, 81^0-34'-55"W and including 800' of the north bank in each direction, and extending offshore to the northern edge of the main channel. When activated, no unauthorized persons shall enter the zone and unauthorized water craft may not approach ships moored within the Security Zone.

2.3.4 Safety Zones

Stationary and moving Safety Zones have been established to protect Maritime Prepositioned Ships moving in the Saint Johns River and when moored at Blount Island facilities. See 33CFR-165.728.

2.3.5 Prohibited Area

The Turning Basin within the USN Air Base Reservation at Mayport has been designated as a "Prohibited Area" by 33CFR334.500. Entry by craft other than those operated by the USN or USCG is prohibited except in cases of extreme emergency.

2.3.6 Restricted Area

The area adjacent to the USN Fuel Depot pier, just north of the Drummond Creek Range, has been designated a "Restricted Area" by 33CFR334.510. Use by private vessels is permitted only when authorized by the Officer-in-Charge, USN Fuel Depot.

2.3.7 Corps of Engineers Regulations

The U. S. Army Corps of Engineers has issued "Navigation Regulations" for all waterways tributary to the Atlantic Ocean south of Chesapeake Bay. The nature of the regulations is general, dealing primarily with use of locks, statistical reporting requirements for commercial vessel operators, pollution prevention and operation of tows. The regulations have no direct impact upon VTS design requirements.

2.4 VESSEL TRAFFIC

The Port of Jacksonville handled 13.5 million tons of cargo in 1987, of which 5.6 million tons were petroleum products (gasoline, jet fuel and heating fuel). That same year there were 436 tanker movements within the waterway, and 2270 barge movements (Reference 2). A discrepancy exists between this data and that provided as the result of the Transportation Systems Center (TSC) visit to Jacksonville in 1990, which indicated that of 8000 ship movements per year, 1400 were tankers. The TSC Trip Report also identified a petroleum product tonnage double that reported by other sources. These discrepancies were not resolved but do not significantly affect VTS design requirements.

U. S. Navy (USN) movements to and from Mayport and the Navy Fuel Depot reach peaks of 300 movements per month. USN traffic is unevenly distributed throughout the year, keyed as it is to operational deployments, maintenance availabilities and training schedules. Peak traffic is considered more germane to VTS design requirements than are averages.

Information is not available about the volume and nature of ICW traffic. While, in general, the volume of commercial traffic is markedly lower than that of the ICW west of New Orleans the volume of recreational traffic is seasonally quite high.

2.5 ENVIRONMENTAL SENSITIVITY

Much of the Saint Johns River is bounded by environmentally sensitive wetlands of major importance to aquatic birds, the spawning of fish and as the habitat of several protected species of wildlife.

The presence of strong currents will make containment of spills difficult and "worse case" is undoubtedly a major petroleum spill at or near maximum ebb somewhere near Dames Point or higher in the river. Economic "worse case" would couple such a spill with channel blockage, probably at Trout River Cut.

2.6 PORT SUB-ZONES

The Study Area was examined to determine appropriate sub-zones, using the methodology based upon the "confined-complex", "open-complex", "confined-simple" and "open-simple" system employed by the Canadian VTS Study in 1984 (Reference 3). Briefly stated, "open" and "confined" address the influence of geography upon a ship's ability to maneuver; and "simple" vs "complex" is descriptive of the nature of the interactions between ships within those geographic areas. This basic matrix was overlaid by a subjective assessment of appropriate traffic management/risk amelioration measures in order to derive sub-zones within which VTS needs are homogeneous, or nearly so.

2.6.1 Sub-Zone I - Offshore Approaches (NOAA Chart 11488)

The sub-zone lies seaward of a line drawn eastward from the shoreline to 30^0-15'N 81^0-10'W, thence to 30^0-30'N 81^0-10'W, and from that point due west to the shoreline.

In general, the sub-zone is free from hazards except for the presence of broken ground with least depths of 4-5 fathoms 4-6 miles from the coast both north and south of the Saint Johns River entrance. A number of fish havens have been established offshore from the Saint Johns River entrance, but are well marked on the chart and generally are covered by at least 50' of water. ("Fish Havens" are man-made reefs created as habitats for sports fish, and are regulated by the U. S. Army Corps of Engineers.)

Aids to navigation, including Loran-C, are considered to be excellent.

The sub-zone is "open-simple."

2.6.2 Sub-Zone II - Saint Johns River Entrance (NOAA Chart 11488)

The sub-zone lies between the inshore boundaries of Sub-Zone I (a line drawn eastward from the shoreline to 30^0-15'N 81^0-10'W, thence to 30^0-30'N 81^0-10'W, and from that point due west to the shoreline) and the COLREGS Demarcation Line at the Saint Johns River entrance jetties.

The sub-zone incorporates the Naval and Explosives Anchorages which lie to the north of the Entrance Channel as well as a Danger Area within which anchoring is not permitted because of the possible presence of the residue of a World War II mine barrage. Shoal water, less than 30', makes out south of the Entrance Channel. The sub-zone contains the Saint Johns Bar Pilot boarding area. Currents across the entrance have a pronounced northerly set, with velocities increased under some wind conditions. Considerable recreational boat traffic may occur near the entrance.

The area is well marked by aids to navigation, including Loran-C, but the buoys watching the entrance channel are subject to displacement from station by storms coupled with strong currents. VTS navigational assistance may be required.

Because of the locations of anchorages and absence of lay-berths ships are committed to continue to their assigned berths once entrance is made. Traffic management advice is required when queuing is necessary and advance information about upstream visibility and tidal conditions is a necessary input to this process.

The sub-zone is classified as "confined-complex."

2.6.3 Sub-Zone III - The Saint Johns River (NOAA Chart 11491)

The sub-zone consists of the Saint Johns River between the COLREGS Demarcation Line at the entrance jetties and the Main Street Lift Bridge in Jacksonville, the Head of Deep-Draft Navigation. That portion of the Intracoastal Waterway (ICW) south of ICW Light 82 and north of ICW Light 11 are included in the sub-zone.

The sub-zone consists of about 23 miles of enhanced river channel of varying widths and depths (Refer to Tabulations, NOAA Chart 11491 for specifics). The channel has a number of sharp bends, is subject to strong tidal currents and several intersections.

Meetings at selected bends and channel sections should be avoided except, in selected cases, by careful prior arrangement. Because of the locations of anchorages and absence of lay-berths ships are committed to complete the downriver transit upon leaving assigned berths. Traffic management advice is required when queuing is necessary and advance information about downstream visibility and tidal conditions is a necessary input to this process.

Because of the narrowness of the channel cross-track navigational assistance is impractical, but along-track information is essential to the overall management process.

The sub-zone is "confined-complex."

2.7 PROBLEM AREA IDENTIFIERS

2.7.1 PAI II-1. Naval and Explosives Anchorages (NOAA Charts 11488 & 11491)

The anchorages established north of the entrance channel are for the use of the U. S. Navy and subject to the control of the Commanding Officer, Naval Station, Mayport.

The ability to maintain surveillance of the anchorage area assists in maintenance of USN control, as well as warn shipping clear of the area when explosives are being handled.

2.7.2 PAI II-2. Saint Johns Bar Cut Range (NOAA Chart 11491)

The entrance to the Saint Johns River is subject to a strong northerly set across the entrance jetties which at times has been strong enough to shift buoys from station. Vessels entering the Saint Johns River from seaward may from time to time require navigational assistance.

The only queuing area available to inbound traffic is seaward of the entrance jetties. A VTS requires the capability to correlate movements upstream, weather and tidal current conditions with entering traffic, providing movement management advice as required for safety.

Entrance visibility and tidal conditions are inputs to vessel traffic movement decisions up river, and real-time monitoring of those conditions is required for safety.

2.7.3 PAI III-1. Mayport Basin Intersection (NOAA Chart 11491)

The bifurcation of the main channel and that into the Mayport Basin requires careful management of traffic flow, particularly when an aircraft carrier is entering or leaving the Basin. The bulk of the USN movements are between Mayport Basin and the sea and Navy movements must be carefully coordinated with other traffic.

The area is also used for making up tows prior to upriver transit and for preparing barges for open-sea towing. Such activity may result in temporary obstruction of the channel, a situation which requires monitoring and coordination with other traffic.

2.7.4 PAI III-2. Mayport (NOAA Chart 11491)

Mayport is a center of recreational boating, including shoreside facilities supporting that activity. There is a cross-channel car ferry in regular operation between the town of Mayport and Fanning Island. The resultant potential occurs near a major channel bend, and surveillance is required to provide traffic management advice.

2.7.5 PAI III-3. Training Wall Reach (NOAA Chart 11491)

Turning Wall Reach, immediately upstream from the channel bend at Mile Point, is where the Intracoastal Waterway (ICW) crosses the main channel at about a 45^0 angle. Commercial and recreational craft cross the main channel at this point and a certain percentage changes from the ICW to the Saint Johns River, and vice versa. The VTC must have the capability of managing traffic so that vessels may move through the intersection safely and smoothly.

2.7.6 PAI III-4. Dames Point Turn (NOAA Chart 11491)

The Dames Point Turn requires major alternations of course under conditions complicated by strong currents and the presence of a bridge. Just east of the Turn two channels join, and the problems of negotiating the turn may be further complicated by the presence of vessels maneuvering to enter or leave the Blount Island Channel.

The VTC must have the capability of managing traffic so that vessels may move through the intersection and turn safely and smoothly. This may include the requirement to manage the movement of main channel traffic so that ships do not meet in the turn itself.

Tidal and visibility information provide important inputs to management of entering and departing shipping.

2.7.7 PAI III-5. Trout River Cut (NOAA Chart 11491)

The Trout River Cut is partially cut into a rock ledge and contact with its hard sides will undoubtedly open a ship's hull. The Cut is only 400' wide and is entered from either end through a turn. Traffic must be managed so that ships do not meet within the Cut or while maneuvering to enter and leave it.

2.7.8 PAI III-6. Long Branch Range (NOAA Chart 11491)

Long Branch Range contains two Federal Anchorages at its southern end, a side channel at its northern end and a number of facilities along its western bank. The anchorages require careful management, both as a queuing resource and to prevent obstruction of traffic by anchored vessels. Movement management advice is required to coordinate the movement of ships through what is potentially a congested area.

2.7.9 PAI III-7. Commodore Point (NOAA Chart 11491)

There is a major channel turn at Commodore Point, with a Federal Anchorage to the south and southwest of the Point. Negotiation of the turn itself is complicated by the presence of a bridge and the effects of currents. There is also a shoal-draft Federal Anchorage just east of Commodore Point.

The anchorages require careful management, both as a queuing resource and to prevent obstruction of traffic by anchored vessels. Movement management advice is required to coordinate the movement of ships through what is potentially a congested and difficult area.

2.7.10 PAI III-8. Upper Jacksonville (NOAA Chart 11491)

"Upper Jacksonville" is considered to be that portion of the Saint Johns River between the Commodore Point Bridge and the Main Street Lift Bridge marking the head of deep-draft navigation. There are numerous facilities along either bank and the possibility of congestion is always present.

The timing of movements of ships departing the area for sea is partially dependent upon tidal conditions and downstream visibility. Ships planning to enter the Saint Johns River from sea need to be aware of tidal conditions and visibility at Jacksonville.

Movement management advice is required to coordinate the movement of ships through what is potentially a congested and difficult area.

3.0 JACKSONVILLE VTS DESIGN

3.1 INTRODUCTION

A detailed survey of the Port of Jacksonville is the basis for this design. An approach to costing VTS systems is outlined in Vol. III, Technical Supplement and a method of categorizing surveillance sensors into "modules" has also been developed. These modules are defined in terms of cost and performance and are to be applied to all VTS designs in this study. The applicability of Automatic Dependent Surveillance (ADS) technology is also discussed in this report. The three sub-zones defined in the harbor survey remain the same.

Traffic management requirements for each sub-zone are developed from PAI analysis. Table 3-1 lists in tabular form a summation of the problems identified and the management required by sub-zone.

The hardware and software selected for this design provide the level of surveillance justified by the problems identified in each sub-zone. A secondary consideration is to locate all VTS assets so that they are sufficient for the sub-zone in question and can contribute to adjoining sub-zones to achieve maximum usage. All specific equipments are then selected based on perceived surveillance requirements and overall VTS system architecture.

3.1.1 VTS Design Approach

The choice of surveillance sensors is dependent on the VTS mission. For the purposes of this design, the VTS mission is defined as that which insures the safety of navigation and the protection of the environment. In order to accomplish this mission, mandatory participation of all vessels over 20 meters is essential. The Vessel Traffic Center (VTC) must provide navigation safety advice to all vessels. The VTS in the United States will have no facilitation of commerce role nor will it offer piloting assistance of any kind.

TABLE 3-1. JACKSONVILLE, FL PROBLEM AREA IDENTIFIERS

PAI	LOCATION	PROBLEM	MANAGEMENT
I	Offshore Approaches	Data catchment area for inbound shipping.	Have real-time knowledge of vessel movements, locations, through reporting. Enter inbound shipping information into data base. Use radar to verify data as appropriate.
II	St. Johns River Entrance	Potential congestion. Navigational assistance may be required. Queuing necessary to prevent unacceptable meetings. Movement management advice required.	Have real-time knowledge of vessel movements. Be able to provide movement management advice and navigational assistance as required. Manage anchorages.
III	St. Johns River	Narrow channels where meetings, overtakings must be managed. Potential for localized congestion. Queuing control required, coupled with anchorage management.	Have real-time knowledge of vessel movements and locations. Provide movement management advice, manage anchorages.

The primary criteria for selection of adequate surveillance sensors are:

- o Percentage of vessels of the desired minimum size detected in designated surveillance areas

- o Percentage of lost tracks

- o Accuracy of the position and track obtained

- o Reliability of the surveillance system

- o Timeliness of the data obtained

- o Ability to interpret and use the data obtained

Secondary criteria are:

- o Cost of the VTS system -- reduction of manpower by the use of technology

- o Expandability -- increased VTS responsibility, area, and/or support of other missions

Active surveillance sensors including radar, communications, and closed circuit television (CCTV) installations are used when detection and tracking of vessels is paramount to providing safety advice. These devices are considered fail safe in that it is known with certainty when they have failed. The performance characteristics of these sensors are known from operational VTS worldwide experience. In this design they are selected to assure that the necessary operational criteria identified for each sub-zone is realized.

Many dependent surveillance techniques are possible. These range from voice radio reporting of required VTS data to automatic position and identification recording devices that can be interrogated from shore known as Automatic Dependent Surveillance (ADS) devices. The position and/or movement reporting form of dependent surveillance is used extensively in existing VTS systems. The major regions of current use are those which do not require active surveillance. To apply ADS technology to a specific sub-zone within a VTS zone the following additional criteria must be considered:

- o The number and class of vessels interacting in the sub-zone and which of these interactions are important to the VTS mission. Obviously all vessel classes of interest must be appropriately equipped. This requires that all vessels of the classes selected which will ever pass through this sub-zone must be equipped with an ADS device. This requirement to detect so many different vessels argues

against the use of ADS. In areas where only one class of vessel is of interest, ADS is more easily implemented.

- The interactions or transits to be monitored must not demand that the surveillance be fail safe, i.e. positively detecting failures. This type of surveillance is related to position reporting in that it may not always function or be used properly and the VTS has limited control over its operation.

- It must be determined that if active surveillance is not justified, the additional information obtained from ADS over position reporting is necessary.

- If the class or group of vessels to be monitored is a "controllable" group, ADS can be easily implemented and satisfactory operation more readily achieved. Controllable means a clearly defined subset of vessels, e.g. a specific barge company; vessels carrying a specific cargo, etc.

- The number of different vessels in each class of interest that passes through the sub-zone in question must be determined. This number must be known to accurately estimate the cost of selecting this option for this sub-zone.

- A specific ADS solution for one sub-zone in one harbor may affect all the VTS designs for all the other sub-zones in all the other harbors.

3.1.2 Assumptions

The design of this VTS system starts with a set of assumptions based on the detailed survey and other data. These assumptions are as follows:

- As recommended by the IMO, all vessels of 20 meters or more in length are required to participate in the VTS. Participation is defined (at a minimum) as monitoring the VTS frequency and reporting as required.

- The VTS system is implemented with the cooperation and assistance of the port authorities, pilots associations, and marine exchange, if any. The existing facilities, services, and procedures established and operated by these organizations are major elements of an integrated VTS system as defined in the IMO VTS Guidelines.

- The life-cycle of all system hardware is ten years.

3.2 DESIGN DECISIONS (FIGURE 3-1)

3.2.1 General

Examination of the traffic levels, geographical features and identified problem areas in this port leads to the following selection and location of sensor hardware.

3.2.2 Hardware Location and Selection

3.2.2.1 Sub-Zone III

East Mayport Site	1 Module 1 radar
	1 Module 10 VHF
	1 Module 11 VHF
	1 Module 13 MET
Blount Island Site	1 Module 10 VHF

3.2.3 Vessel Traffic Center

The design of the hardware and software should be modern and capable of operating with reduced staff levels and no loss of effectiveness. One watchstander with an integrated data workstation and decision aiding software can effectively manage the activity in this port. This Vessel Traffic Center concept demands that the watchstander be separated from any other harbor/port information requests. The Center must be structured so that such requests are controlled by a bulletin board type interface. One officer-in-charge and one clerk are also required for the proper administration of the facility.

The Vessel Traffic Center is located in Mayport in a location with good visual surveillance of the entrance and the river. The center is to employ the following equipment:

3.2.3.1 VTS Console

This console provides total data integration from all sensors in all sectors. These data are graphically shown on raster scan, high light level, color displays. A data display is also provided. Console design architecture is general purpose computer based, open architecture, bus organized, allowing operation of the system as a local area network (LAN). Data interchange with other facilities by modem is provided as well as interface with the U.S. Coast Guard standard terminal. The design allows board level modification and expansion. Features of the software and hardware provided are:

Surveillance Modules -Sub Zones	RADAR						ADS			VHF		MET.		HYD.		DF	CCTV		COMMENTS
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
I																			Comms coverage from facilities in Sub-Zone III
II																			Comms/Radar coverage from Sub-Zone III
III	1									2	1		1						VTC located at Mayport

FIGURE 3-1. JACKSONVILLE, FL SURVEILLANCE SURVEY

- Software written in a high level language.
- Software providing the total integration of data from all VTS sensors.
- Layering of data in at least four layers to be operator selectable.
- The ability to sector data including sector to sector handoff of targets.
- The ability to accept external digital data derived from transmissions of shipboard transponders or other sources and integrate the information with all other sensor data.
- Automatic and/or manual acquisition of radar targets including automatic tracking and target ID assignments. Guard zones with automatic acquisition of all targets entering the zone.
- Several warning levels of vessel interaction designed to direct attention to developing situations rather than a simple CPA alarm strategy.
- Complete vessel monitoring and alarm capability including anchor watch, CPA, TCPA, track history, adjustable target velocity vectors, restricted area penetration and maneuvering monitor is provided. Additional warning and/or alarm features allowed by programming changes in high level language.
- Complete modern color graphics capability with offset and zoom
- Complete harbor navigation aid monitoring capability including buoy position, light status, etc.
- Remote control of all radars and radar interfaces as well as radar data processing including site-to-site integration, clutter suppression, scan conversion and target extraction.
- Complete track projection capability which can predict and/or analyze future interactions based on current position, destination and velocity.
- The capability of constructing a complete vessel data base and interfacing it to the real-time data display from the VTS sensors.

3.2.3.2 Communications Console

This console is capable of remotely operating the proposed transmitting/receiving sites and allowing transmission and

monitoring on all required frequencies. The console provides two operating positions each to be capable of complete communications control. It is capable of modular expansion if other remote communications sites are added.

3.2.3.3 Supervisor Control and Data Acquisition (SCADA) Equipment

A SCADA capability is provided to the major module level at remote sites so that the watchstander can determine the status of the entire VTS system. A graphic readout is provided in block diagram form indicating operational status of all elements in the system. Security monitoring of remote sites is also included.

3.2.3.4 Recording Equipment

Time synchronized video and audio recording equipment is to be provided. This equipment is capable of recording and playing back the data presented to the VTS watchstander and his reaction to the situation. An extra set of recording equipment is to be installed for redundancy purposes.

3.3 COST ESTIMATES

3.3.1 General

Vol. III, Technical Supplement discusses a generalized approach to estimating VTS system costs. This approach is based on interviews with system designers and purchasers of recently constructed systems. The cost of this VTS system has been estimated using this approach and is detailed below. The assumptions made in estimating these costs are listed in Paragraph 3.1.2.

3.3.2 Hardware Costs (x $1000)

Vessel Traffic Center	non-recurring	recurring(10-yr)
VTS Console (1 workstation & all software)	500	
Communications console	100	
Recording Equipment	50	
SCADA Equipment (1 radar site)	200	
Sub-total:	850	400

Sub-Zone I--Offshore Approaches (NOAA Chart 11488)

Comms coverage from facilities in Sub-Zone III.

Sub-Zone II--Saint Johns River Entrance (NOAA Chart 11488)

Comms/radar coverage from Sub-Zone III.

Sub-Zone III--Saint Johns River (NOAA Chart 11491)

1 Module 1 radar	310	310
2 Module 10 VHF	38	26
1 Module 11 VHF	48	20
1 Module 13 MET	40	5
Sub-total:	436	361
HARDWARE TOTALS:	1286	761

3.3.3 Project Totals (x$1000)

Non-recurring

Hardware	$1286
Management, Engineering, etc. (50%) Assumptions: Turnkey system, Procurement by integ.contractor, good manufacturer support, some software provided, System Manual required	643
Installation site integration (20%) Assumptions: Complete installation by contractor, remote access no serious problem, many widespread sites	257
Spares & Training (10%)	129
Civil Engineering 1 remote radar site, a VTC in Mayport, remote comms and WX sensors installations, land acquisition	1000
PROJECT ESTIMATE:	3315
Data Base Management System	300
TOTAL: (non-recurring)	$ 3615

Recurring (10 year)

Hardware	761
1 Watchstander x 5 = 5 man/years @ 50K x 10	2500
1 Officer-in-Charge	500
1 Clerk	500

TOTAL: (recurring) (10-year life) $ 4261

TOTAL 10-YEAR PROJECT COST: $ 7876

REFERENCES

1. United States Coast Pilot No. 4, Atlantic Coast: Cape Henry to Key West, 26th Edition, 1989, NOAA, Washington, D.C. pp. 144-145.

2. Summary Statistics on Leading U.S. Ports, Center for Marine Conservation, Washington, D.C. 1990.

3. Final Report, National Vessel Traffic Services Study (TP5965E), Canadian Coast Guard, Ottawa 1984, pp. 89-91.

GLOSSARY

ADS: Automatic Dependent Surveillance

ARPA: Automatic Radar Plotting Aid.

"CONFINED-COMPLEX": a combination of terms relating to the geography and the nature of the interactions between ships. See Final Report National Vessel Traffic Services Study (TP-5965E), Canadian Coast Guard, Ottawa, October 1984, pp.89-91.

"CONFINED-SIMPLE": a combination terms relating to the geography and the nature of the interactions between ships. See Final Report National Vessel Traffic Services Study (TP-5965E), Canadian Coast Guard, Ottawa, October 1984, pp.89-91.

COTP: Captain of the Port

CCTV: closed circuit television

COLREGS LINE: a demarcation line delineating those waters upon which international regulations for the prevention of collisions at sea apply.

CPA: closest point of approach

DBMS: data base management system

DF: direction finder

FAA: Federal Aviation Administration

GIS: Geographic Information System

ICW: Intracoastal Waterway

IMO: International Maritime Organization

KW: Kilowatt

LAN: local area network

LLOYD'S LIST: a listing of all merchant vessels of the world including their physical characteristics. Published by Lloyd's of London.

LNG: liquified natural gas

NOAA: National Oceanic and Atmospheric Administration

"OPEN-COMPLEX": a combination of terms relating to the geography and the nature of the interactions between ships. See Final Report National Vessel Traffic Services Study (TP-5965E), Canadian Coast Guard, Ottawa, October 1984, pp. 89-91.

"OPEN-SIMPLE": a combination of terms relating to the geography and the nature of the interactions between ships. See Final Report National Vessel Traffic Services Study (TP-5965E), Canadian Coast Guard, Ottawa, October 1984, pp. 89-91.

PAI: Problem Area Identifier

PRECAUTIONARY AREA: an area normally an intersection, entrance to, or exit from a traffic separation scheme where vessel interactions are unpredictable

SCADA: Supervisor Control and Data Acquisition

TCPA: time of closest point of approach

TRAFFIC SEPARATION SCHEME: routes incorporating traffic separation to increase the safety of navigation, particularly in converging areas of high traffic density.

VHF: very high frequency

VTC: vessel traffic center

VTS: vessel traffic services

STUDY ZONE INPUT DATA AND OUTPUT STATISTICS

Appendix U Zone 21 Jacksonville, FL

TABLE 1 Assignment of COE Waterway Codes to Subzones 8/06/91

COE Waterway		Name
Subzone 2101A		
2017	A	JACKSONVILLE HARBOR, FLA.
2046	A	INTRACOASTAL WATERWAY, JACKSONVILLE TO MIAMI, FLA.
5695	A	ATLANTIC INTRACOASTAL WATERWAY BETWEEN NORFOLK, VA., AND
Subzone 2102E		
2017	A	JACKSONVILLE HARBOR, FLA.
2017	B	JACKSONVILLE HARBOR, FLA.
2046	A	INTRACOASTAL WATERWAY, JACKSONVILLE TO MIAMI, FLA.
2046	B	INTRACOASTAL WATERWAY, JACKSONVILLE TO MIAMI, FLA.
5695	A	ATLANTIC INTRACOASTAL WATERWAY BETWEEN NORFOLK, VA., AND
5695	B	ATLANTIC INTRACOASTAL WATERWAY BETWEEN NORFOLK, VA., AND

TABLE 2 Base Year 1987 Cargo Tons by Subzone, Commodity, and Vessel Type

Subzone 2101A

Comm. Code	Name	Dry Cargo	Tanker	Dry Cargo Barge Tow	Tanker Barge Tow	Total
1	FARM PRODUCTS	394,049	0	0	0	394,049
2	FOREST PRODUCTS	2,304	0	0	0	2,304
3	FISHERIES PRODUCTS	10,212	0	0	0	10,212
4	MINING PRODUCTS, NEC	1,355,260	0	21,558	0	1,376,818
5	PROC. FOODS & MFTRS, NEC	4,130,481	0	173,874	0	4,304,355
6	WASTE OF MANUFACTURING	91,052	0	48,158	0	139,210
1311	CRUDE PETROLEUM	0	53,995	0	3,869	57,864
1492	SULPHUR, DRY	10,778	0	0	0	10,778
2810	SODIUM HYDROXIDE (CAUSTI	201,731	0	65,404	0	267,135
2811	CRUDE PROD-COAL TAR-PET	8,655	0	0	0	8,655
2813	ALCOHOLS	0	2,757	0	6,148	8,905
2818	SULPHURIC ACID	111	72	0	8	191
2871	NITROGEN CHEM FERTILIZER	293	397	0	47	737
2872	POTASSIC CHEM FERTILIZER	1,071,601	0	0	0	1,071,601
2873	PHOSPHA CHEM FERTILIZERS	46,258	0	0	0	46,258
2911	GASOLINE, INCL NATURAL	0	2,211,824	0	316,031	2,527,855
2912	JET FUEL	0	134,141	0	63,873	198,014
2913	KEROSENE	0	10,340	0	741	11,081
2914	DISTILLATE FUEL OIL	0	913,298	0	247,599	1,160,897
2915	RESIDUAL FUEL OIL	0	1,154,892	0	1,176,661	2,331,553
2916	LUBRIC OILS-GREASES	0	23,509	0	2,223	25,732
2917	NAPHTHA, PETRLM SOLVENTS	0	1,271	0	150	1,421
2921	LIQUI PETR-COAL-NATR GAS	0	329	0	39	368
	Subzone Total :	7,322,785	4,506,825	308,994	1,817,389	13,955,993

Subzone 2102E

Comm. Code	Name	Dry Cargo	Tanker	Dry Cargo Barge Tow	Tanker Barge Tow	Total
1	FARM PRODUCTS	394,049	0	0	0	394,049
2	FOREST PRODUCTS	2,304	0	0	0	2,304
3	FISHERIES PRODUCTS	10,212	0	0	0	10,212
4	MINING PRODUCTS, NEC	1,355,260	0	21,558	0	1,376,818
5	PROC. FOODS & MFTRS, NEC	4,130,481	0	173,874	0	4,304,355
6	WASTE OF MANUFACTURING	91,052	0	48,158	0	139,210
1311	CRUDE PETROLEUM	0	53,995	0	3,869	57,864
1492	SULPHUR, DRY	10,778	0	0	0	10,778
2810	SODIUM HYDROXIDE (CAUSTI	201,731	0	65,404	0	267,135
2811	CRUDE PROD-COAL TAR-PET	8,655	0	0	0	8,655
2813	ALCOHOLS	0	2,757	0	6,148	8,905
2818	SULPHURIC ACID	111	72	0	8	191
2871	NITROGEN CHEM FERTILIZER	293	397	0	47	737
2872	POTASSIC CHEM FERTILIZER	1,071,601	0	0	0	1,071,601
2873	PHOSPHA CHEM FERTILIZERS	46,258	0	0	0	46,258
2911	GASOLINE, INCL NATURAL	0	2,211,824	0	316,031	2,527,855
2912	JET FUEL	0	134,141	0	63,873	198,014
2913	KEROSENE	0	10,340	0	741	11,081
2914	DISTILLATE FUEL OIL	0	913,298	0	247,599	1,160,897
2915	RESIDUAL FUEL OIL	0	1,154,892	0	1,176,661	2,331,553
2916	LUBRIC OILS-GREASES	0	23,509	0	2,223	25,732
2917	NAPHTHA, PETRLM SOLVENTS	0	1,271	0	150	1,421
2921	LIQUI PETR-COAL-NATR GAS	0	329	0	39	368
	Subzone Total :	7,322,785	4,506,825	308,994	1,817,389	13,955,993

7/22/91

Appendix U ZONE 21 Jacksonville, FL

TABLE 3 Base Year (1987)
Vessel Transits by Subzone, Vessel Type, and Size.

Vessel Type	Large	Medium	Small	Total
Subzone : 2101A				
Passenger	0	0	250	250
Dry Cargo	152	2,017	1,323	3,492
Tanker	160	220	60	440
Dry Cargo Barge Tow	17	0	186	203
Tanker Barge Tow	173	0	556	729
Tug/Tow Boat	205	0	110	315
Subzone Total:	707	2,237	2,485	5,429
Subzone : 2102E				
Passenger	0	0	24,278	24,278
Dry Cargo	152	2,017	6,613	8,782
Tanker	160	220	60	440
Dry Cargo Barge Tow	17	0	928	945
Tanker Barge Tow	173	0	2,780	2,953
Tug/Tow Boat	205	0	552	757
Subzone Total:	707	2,237	35,211	38,155

Note: Sum of all vessel transits within each study subzone.

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Appendix U ZONE 21 Jacksonville, FL

TABLE 3 Base Year (1987)
Vessel Transits by Suzone, Vessel Type, Size.

ZONE TOTALS

ZONE 21 Jacksonville, FL

Vessel Type	Large	Medium	Small	Total
Passenger	0	0	24,278	24,278
Dry Cargo	152	2,017	6,613	8,782
Tanker	160	220	60	440
Dry Cargo Barge Tow	17	0	928	945
Tanker Barge Tow	173	0	2,780	2,953
Tug/Tow Boat	205	0	552	757
Zone Total:	707	2,237	35,211	38,155

Note: Sum of all arrivals/departures to/from all terminals within the Study Zone.

Appendix U Zone 21 Jacksonville, FL

TABLE 4 Barges Per Tow - Average Factors by COE Waterway 8/6/91

COE Code	Waterway Name	Dry Barge	Tank Barge
SUBZONE	All Subzones within this Zone	1	1

NOTE: Average size of tows arriving/departing terminals within the waterway. Sizes of other tows transiting the area may differ.

Appendix U Zone 21 Jacksonville, FL

TABLE 5 Other Local Vessels by Subzone *7/21/91*

Subzone	Name	Number of Vessels	Vessels per Square Mile
2102E		30,382	690.50
	Total for Zone	30,382	123.50

Note: State registered (1989/90) vessels estimated to be operated within the Subzone.

Appendix U ZONE 21 Jacksonville, FL

TABLE 6.1 Forecast 1995
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 2101A				
Passenger	0	0	268	268
Dry Cargo	191	2,509	7,966	10,666
Tanker	175	238	62	475
Dry Cargo Tow	0	0	1,074	1,074
Tanker Tow	191	0	3,111	3,302
Tug/Tow Boat	0	0	574	574
Subzone Total:	557	2,747	13,055	16,359
Subzone : 2102E				
Passenger	0	0	26,013	26,013
Dry Cargo	191	2,509	7,966	10,666
Tanker	175	238	62	475
Dry Cargo Tow	0	0	1,074	1,074
Tanker Tow	191	0	3,111	3,302
Tug/Tow Boat	0	0	574	574
Subzone Total:	557	2,747	38,800	42,104

Note: Sum of all vessel transits within each study subzone.

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Appendix U ZONE 21 Jacksonville, FL

TABLE 6.2 Forecast 2000
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 2101A				
Passenger	0	0	287	287
Dry Cargo	221	2,915	8,960	12,096
Tanker	187	257	66	510
Dry Cargo Tow	0	0	1,180	1,180
Tanker Tow	204	0	3,341	3,545
Tug/Tow Boat	0	0	633	633
Subzone Total:	612	3,172	14,467	18,251
Subzone : 2102E				
Passenger	0	0	27,872	27,872
Dry Cargo	221	2,915	8,960	12,096
Tanker	187	257	66	510
Dry Cargo Tow	0	0	1,180	1,180
Tanker Tow	204	0	3,341	3,545
Tug/Tow Boat	0	0	633	633
Subzone Total:	612	3,172	42,052	45,836

Note: Sum of all vessel transits within each study subzone.

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Appendix U ZONE 21 Jacksonville, FL

TABLE 6.3 Forecast 2005
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 2101A				
Passenger	0	0	299	299
Dry Cargo	257	3,418	10,087	13,762
Tanker	200	276	69	545
Dry Cargo Tow	0	0	1,292	1,292
Tanker Tow	219	0	3,587	3,806
Tug/Tow Boat	0	0	707	707
Subzone Total:	676	3,694	16,041	20,411
Subzone : 2102E				
Passenger	0	0	29,062	29,062
Dry Cargo	257	3,418	10,087	13,762
Tanker	200	276	69	545
Dry Cargo Tow	0	0	1,292	1,292
Tanker Tow	219	0	3,587	3,806
Tug/Tow Boat	0	0	707	707
Subzone Total:	676	3,694	44,804	49,174

Note: Sum of all vessel transits within each study subzone.

TABLE 6.4 Forecast 2010
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 2101A				
Passenger	0	0	312	312
Dry Cargo	302	4,046	11,366	15,714
Tanker	214	298	75	587
Dry Cargo Tow	0	0	1,418	1,418
Tanker Tow	236	0	3,851	4,087
Tug/Tow Boat	0	0	793	793
Subzone Total:	752	4,344	17,815	22,911
Subzone : 2102E				
Passenger	0	0	30,303	30,303
Dry Cargo	302	4,046	11,366	15,714
Tanker	214	298	75	587
Dry Cargo Tow	0	0	1,418	1,418
Tanker Tow	236	0	3,851	4,087
Tug/Tow Boat	0	0	793	793
Subzone Total:	752	4,344	47,806	52,902

Note: Sum of all vessel transits within each study subzone.

Appendix U ZONE 21 Jacksonville, FL

TABLE 6.5 Forecast 1995 - 2010 Vessel Transits by Vessel Type and Size

Vessel Type	Large	Medium	Small	Total
1995 FORECASTED ZONE TOTALS				
Passenger	0	0	26,013	26,013
Dry Cargo	176	2,337	7,945	10,458
Tanker	175	238	62	475
Dry Cargo Tow	0	0	1,074	1,074
Tanker Tow	191	0	3,111	3,302
Tug/Tow Boat	0	0	574	574
1995 Zone Total:	542	2,575	38,779	41,896
2000 FORECASTED ZONE TOTALS				
Passenger	0	0	27,872	27,872
Dry Cargo	194	2,601	8,922	11,717
Tanker	187	257	66	510
Dry Cargo Tow	0	0	1,180	1,180
Tanker Tow	204	0	3,341	3,545
Tug/Tow Boat	0	0	633	633
2000 Zone Total:	585	2,858	42,014	45,457
2005 FORECASTED ZONE TOTALS				
Passenger	0	0	29,062	29,062
Dry Cargo	226	2,983	10,035	13,244
Tanker	200	276	69	545
Dry Cargo Tow	0	0	1,292	1,292
Tanker Tow	219	0	3,587	3,806
Tug/Tow Boat	0	0	707	707
2005 Zone Total:	645	3,259	44,752	48,656
2010 FORECASTED ZONE TOTALS				
Passenger	0	0	30,303	30,303
Dry Cargo	265	3,531	11,307	15,103
Tanker	214	298	75	587
Dry Cargo Tow	0	0	1,418	1,418
Tanker Tow	236	0	3,851	4,087
Tug/Tow Boat	0	0	793	793
2010 Zone Total:	715	3,829	47,747	52,291

Note: Sum of all arrivals/departures to/from all terminals within the study zone.

TABLE 7 Vessel Casualty History (10 Year Totals) by Subzone, Vessel Type and Size, and Casualty Type

Vessel Type	Size	Collisions	Rammings	Groundings	Other	Total
Subzone: 2101A						
Tanker	Large	0	1	0	0	1
Dry Cargo Barge Tow	Small	0	0	0	1	1
Fishing	Small	2	1	0	0	3
Subzone Totals:		2	2	0	1	5
Subzone: 2102E						
Passenger	Small	0	0	3	0	3
Dry Cargo	Large	0	0	3	0	3
Dry Cargo	Medium	0	0	1	0	1
Dry Cargo	Small	2	0	0	0	2
Tanker	Large	1	0	2	0	3
Dry Cargo Barge Tow	Small	0	1	1	0	2
Tanker Barge Tow	Large	0	0	1	0	1
Tanker Barge Tow	Small	0	0	3	0	3
Tug/Tow Boat	Small	1	1	0	0	2
Fishing	Small	1	0	0	0	1
Other	Small	1	1	0	0	2
Subzone Totals:		6	3	14	0	23
Zone Totals:		8	5	14	1	28

Note: OTHER equals barge breakaways and weather caused vessel casualties.

APPENDIX TABLE U-8 ZONE 21, JACKSONVILLE, FL - VTS LEVELS IN OPERATION

APPENDIX TABLE U-9 ZONE 21, JACKSONVILLE, FL - CANDIDATE VTS DESIGN - 1995-2010

UNITS

1	Radar Module 1	- Average Performance
0	Radar Module 2	- Average Performance
0	Radar Module 3	- High Performance
0	Radar Module 4	- High Performance
0	Radar Module 5	- Special Purpose
0	Radar Module 6	- Special Purpose
0	ADS Module 7	- Active Radar Transponder (Type 1)
0	ADS Module 8	- Positional Transponder, Small Area, Very High Accuracy (Type 5)
0	ADS Module 9	- Positional Transponder, Small Area, High Accuracy (Type 6)
2	VHF Module 10	- Low power VHF Transmitting/ Receiving Facility
1	VHF Module 11	- High power VHF Transmitting/ Receiving Facility
0	Meteorological Module 12	- Air temperature, wind direction and speed
1	Meteorological Module 13	- Air temperature, wind direction and speed, visibility
0	Hydrological Module 14	- Water Temperature and Depth
0	Hydrological Module 15	- Water Temperature, Depth and Current
0	VHF/DF MODULE 16	- Line of position measurement to 2 degree RMS
0	CCTV MODULE 17	- Fixed Focus CCTV via Telephone Lines
0	CCTV MODULE 18	- Remotely Controllable CCTV via

Appendix U Zone 21 Jacksonville, FL

TABLE 10A Avoided Vessel Casualties 1996 - 2010 Candidate VTS Systems 7/31/91

Counts

Vessel Type	Size	Collision	Ramming	Grounding	Total
Passenger	Small	.34	.10	.20	.64
Dry Cargo	Large	.08	.02	.09	.19
Dry Cargo	Medium	.41	.10	.15	.66
Dry Cargo	Small	.28	.06	.03	.37
Tanker	Large	.14	.05	.18	.37
Tanker	Medium	.02	.00	.01	.04
Tanker	Small	.00	0.00	.00	.00
Dry Cargo Barge T	Small	.15	.08	.04	.27
Tanker Barge Tow	Large	.05	.03	.03	.11
Tanker Barge Tow	Small	.47	.15	.20	.83
Tug/Tow Boat	Small	.00	.00	.00	.01
		1.95	.61	.93	3.48

Undiscounted Total Dollar Losses (1,000)

Vessel Type	Size	Collision	Ramming	Grounding	Total
Passenger	Small	268	79	118	465
Dry Cargo	Large	109	38	28	175
Dry Cargo	Medium	541	166	41	748
Dry Cargo	Small	170	40	16	225
Tanker	Large	794	292	378	1,463
Tanker	Medium	35	6	7	48
Tanker	Small	1	0	0	2
Dry Cargo Barge T	Small	8	13	1	22
Tanker Barge Tow	Large	272	201	110	584
Tanker Barge Tow	Small	1,408	475	106	1,988
Tug/Tow Boat	Small	0	0	0	1
		3,607	1,308	805	5,720

Note: In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 11 Avoided Fatalities 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Small	.02	.01	.01	.04
Dry Cargo	Large	.01	.00	.01	.02
Dry Cargo	Medium	.05	.01	.02	.08
Dry Cargo	Small	.02	.00	.00	.02
Tanker	Small	.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	.00	.00	.00	.00
Tanker Barge Tow	Small	.00	.00	.00	.00
Tug/Tow Boat	Small	.00	.00	.00	.00
Totals		.10	.03	.04	.17
Candidate VTS Design - Dollars					
Passenger	Small	32,922.15	9,366.08	19,290.95	61,579.17
Dry Cargo	Large	14,637.06	3,820.59	16,445.04	34,902.69
Dry Cargo	Medium	77,290.03	19,109.54	27,906.38	124,305.95
Dry Cargo	Small	26,957.32	5,729.00	3,007.21	35,693.53
Tanker	Small	6.96	0.00	4.29	11.25
Dry Cargo Barge Tow	Small	493.60	279.30	126.23	899.12
Tanker Barge Tow	Small	1,558.68	509.00	669.64	2,737.32
Tug/Tow Boat	Small	9.94	5.92	5.68	21.54
Totals		153,875.74	38,819.42	67,455.42	260,150.58

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 12 Avoided Human Injuries 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Small	.26	.07	.15	.49
Dry Cargo	Large	.00	.00	.00	.00
Dry Cargo	Medium	.01	.00	.00	.01
Dry Cargo	Small	.21	.05	.02	.28
Tanker	Small	.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	.00	.00	.00	.01
Tanker Barge Tow	Small	.01	.00	.00	.02
Tug/Tow Boat	Small	.00	.00	.00	.00
Totals		.50	.13	.19	.81
Candidate VTS Design - Dollars					
Passenger	Small	61,992.95	17,636.47	36,325.17	115,954.60
Dry Cargo	Large	251.31	65.60	282.36	599.27
Dry Cargo	Medium	1,327.05	328.11	479.15	2,134.30
Dry Cargo	Small	50,761.09	10,787.80	5,662.63	67,211.51
Tanker	Small	12.16	0.00	7.49	19.66
Dry Cargo Barge Tow	Small	862.47	488.02	220.56	1,571.05
Tanker Barge Tow	Small	2,723.50	889.38	1,170.07	4,782.96
Tug/Tow Boat	Small	17.37	10.35	9.93	37.64
Totals		117,947.91	30,205.72	44,157.35	192,310.98

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 13 Avoided Vessels Damaged 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Small	.29	.07	.06	.42
Dry Cargo	Large	.06	.01	.01	.08
Dry Cargo	Medium	.30	.07	.01	.39
Dry Cargo	Small	.24	.04	.02	.30
Tanker	Large	.11	.04	.02	.17
Tanker	Medium	.02	.00	.00	.02
Tanker	Small	.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	.11	.04	.01	.15
Tanker Barge Tow	Large	.04	.02	.01	.06
Tanker Barge Tow	Small	.36	.07	.03	.45
Tug/Tow Boat	Small	.00	.00	.00	.00
Totals		1.54	.35	.17	2.06
Candidate VTS Design - Dollars					
Passenger	Small	99,602.03	22,147.77	32,338.21	154,088.01
Dry Cargo	Large	42,543.45	10,627.23	5,064.24	58,234.92
Dry Cargo	Medium	271,398.29	64,216.16	6,425.11	342,039.56
Dry Cargo	Small	45,670.88	7,892.30	4,211.56	57,774.74
Tanker	Large	83,560.87	31,539.65	49,794.18	164,894.71
Tanker	Medium	12,001.12	1,836.61	3,141.18	16,978.91
Tanker	Small	137.97	0.00	110.83	248.80
Dry Cargo Barge Tow	Small	6,615.48	2,072.73	270.12	8,958.33
Tanker Barge Tow	Large	6,747.60	2,671.80	1,079.00	10,498.41
Tanker Barge Tow	Small	25,521.87	4,614.93	2,545.79	32,682.59
Tug/Tow Boat	Small	37.93	14.51	21.08	73.51
Totals		593,837.48	147,633.70	105,001.30	846,472.48

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 14 Avoided Cargo Damage/Loss 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Small	.07	.02	.02	.11
Dry Cargo	Large	.02	.01	.01	.04
Dry Cargo	Medium	.11	.04	.01	.16
Dry Cargo	Small	.09	.02	.01	.11
Tanker	Large	.04	.01	.02	.07
Tanker	Medium	.01	.00	.00	.01
Tanker	Small	.00	0.00	.00	.00
Dry Cargo Tow	Small	.02	.01	.00	.04
Tanker Tow	Large	.00	.00	.00	.01
Tanker Tow	Small	.07	.02	.01	.10
Tug/Tow Boat	Small	.00	.00	.00	.00
Totals		.43	.13	.08	.63
Candidate VTS Design - Dollars					
Passenger	Small	251.89	56.01	73.03	380.93
Dry Cargo	Large	219.04	81.00	23.27	323.31
Dry Cargo	Medium	1,156.61	405.15	39.49	1,601.25
Dry Cargo	Small	207.27	35.82	18.91	261.99
Tanker	Large	2,563.56	919.78	2,665.16	6,148.50
Tanker	Medium	96.07	14.46	19.32	129.84
Tanker	Small	3.72	0.00	1.18	4.89
Tanker Tow	Large	1,516.84	1,088.04	868.16	3,473.04
Tanker Tow	Small	5,993.44	1,956.90	1,049.40	8,999.74
Tug/Tow Boat	Small	.46	.17	.25	.88
Totals		12,008.88	4,557.33	4,758.16	21,324.37

Note1: Dollar values include bulk petroleum and chemical cargos only and all vessel fuels spilled. Dollar values exclude cargo loss/damage for non-tank vessel types.

Note2: In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Count totals were calculated before rounding.

TABLE 15 Avoided NavAid Damage 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Small	0.00	.01	.00	.01
Dry Cargo	Large	0.00	.00	.00	.00
Dry Cargo	Medium	0.00	.01	.00	.01
Dry Cargo	Small	0.00	.01	.00	.01
Tanker	Large	0.00	.01	.00	.01
Tanker	Medium	0.00	.00	.00	.00
Tanker	Small	0.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	0.00	.01	.00	.01
Tanker Barge Tow	Large	0.00	.00	.00	.00
Tanker Barge Tow	Small	0.00	.02	.00	.02
Tug/Tow Boat	Small	0.00	.00	.00	.00
Totals		0.00	.07	.01	.07
Candidate VTS Design - Dollars					
Passenger	Small	0.00	62.97	6.49	69.46
Dry Cargo	Large	0.00	13.11	2.83	15.94
Dry Cargo	Medium	0.00	65.58	4.79	70.37
Dry Cargo	Small	0.00	38.52	1.01	39.53
Tanker	Large	0.00	32.38	5.70	38.08
Tanker	Medium	0.00	2.24	.43	2.67
Tanker	Small	0.00	0.00	.04	.04
Dry Cargo Barge Tow	Small	0.00	54.54	1.23	55.78
Tanker Barge Tow	Large	0.00	21.17	.87	22.05
Tanker Barge Tow	Small	0.00	99.40	6.55	105.95
Tug/Tow Boat	Small	0.00	1.16	.06	1.21
Totals		0.00	391.06	30.01	421.07

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 16 Avoided Bridge Damage 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Small	.00	.01	0.00	.01
Dry Cargo	Large	0.00	.00	0.00	.00
Dry Cargo	Medium	0.00	.01	0.00	.01
Dry Cargo	Small	.00	.00	0.00	.00
Tanker	Large	0.00	.01	0.00	.01
Tanker	Medium	0.00	.00	0.00	.00
Tanker	Small	.00	0.00	0.00	.00
Dry Cargo Barge Tow	Small	.00	.01	0.00	.01
Tanker Barge Tow	Large	0.00	.00	0.00	.00
Tanker Barge Tow	Small	.00	.01	0.00	.01
Tug/Tow Boat	Small	.00	.00	0.00	.00
Totals		.00	.05	0.00	.05
Candidate VTS Design - Dollars					
Passenger	Small	951.31	12,182.03	0.00	13,133.34
Dry Cargo	Large	0.00	4,110.56	0.00	4,110.56
Dry Cargo	Medium	0.00	20,559.90	0.00	20,559.90
Dry Cargo	Small	741.87	7,231.48	0.00	7,973.34
Tanker	Large	0.00	10,151.19	0.00	10,151.19
Tanker	Medium	0.00	702.04	0.00	702.04
Tanker	Small	4.63	0.00	0.00	4.63
Dry Cargo Barge Tow	Small	394.57	10,240.39	0.00	10,634.97
Tanker Barge Tow	Large	0.00	6,637.56	0.00	6,637.56
Tanker Barge Tow	Small	1,245.97	18,662.52	0.00	19,908.49
Tug/Tow Boat	Small	6.61	192.16	0.00	198.77
Totals		3,344.96	90,669.83	0.00	94,014.80

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

Appendix U Zone 21 Jacksonville, FL
TABLE 17 Avoided Hazardous Commodity Spills 1996 - 2010 7/30/91

Commodity	Catastrophic	Large	Medium	Small	Total
Candidate Vts Design - Counts					
ALCOHOLS	.00	.00	.00	.00	.00
KEROSENE	.00	.00	.00	.00	.00
CRUDE PETROLEUM	.00	.00	.00	.00	.00
JET FUEL	.00	.00	.00	.00	.00
DISTILLATE FUEL OIL	.00	.00	.01	.16	.17
GASOLINE, INCL NATURAL	.00	.01	.01	.00	.03
RESIDUAL FUEL OIL	.00	.02	.10	.13	.25
	.01	.03	.13	.28	.45

Note: In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

Appendix U Zone 21 Jacksonville, FL
TABLE 18A Annual Benefit & Cost Streams 7/31/91
Candidate VTS Systems

Discounted to 1993

Year	Investment ($1,000)	Operation & Maintenance ($1,000)	Benefits ($1,000)
1993	3,615	0	0
1996	0	335	242
1997	0	305	227
1998	0	277	198
1999	0	252	417
2000	0	229	162
2001	0	208	159
2002	0	189	150
2003	0	172	148
2004	0	156	139
2005	0	142	128
2006	0	129	116
2007	0	118	109
2008	0	107	99
2009	0	97	92
2010	0	88	86
	3,615	2,806	2,473

Undiscounted

Year	Investment ($1,000)	Operation & Maintenance ($1,000)	Benefits ($1,000)
1993	3,615	0	0
1996	0	426	308
1997	0	426	317
1998	0	426	305
1999	0	426	706
2000	0	426	301
2001	0	426	325
2002	0	426	338
2003	0	426	366
2004	0	426	378
2005	0	426	385
2006	0	426	382
2007	0	426	395
2008	0	426	396
2009	0	426	402
2010	0	426	416
	3,615	6,392	5,720

APPENDIX U

ZONE 21 - JACKSONVILLE, FL

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Jacksonville Port & Subzone	(Port 21) Species Category	Species Code	Species Name	Wildlife Abundance Tables Fish & Shellfish Grams per Square Meter Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
2101	101	2	Alewife	.0010	.0010	.0010	.0010
2101	102	3	Menhaden	3.7000	1.0000	3.7000	10.1000
2101	102	5	Butterfish	.0465	.0013	.0013	.0465
2101	102	32	King Mackerel	.3300	.3300	.3300	.3300
2101	102	42	Atl. Thread Herring	.0065	.0051	.0100	.0023
2101	102	43	Cuban Anchovy	.0062	0.0000	.0062	.0062
2101	102	43	Dusty Anchovy	.0010	0.0000	.0010	.0010
2101	102	43	Flat Anchovy	0.0000	.0028	.0980	0.0000
2101	102	43	Striped Anchovy	.0111	0.0000	.0111	.0111
2101	102	44	Striped Mullet	.1200	.1200	.1200	.1200
2101	102	72	Spanish Sardine	.0008	.0273	.0273	.0008
2101	102	128	Sea Robin	.0402	.0255	.0003	0.0000
2101	102	130	Orange Filefish	.0700	.0336	.0336	.0700
2101	103	8	Bluefish	.9600	0.0000	.9600	1.7100
2101	103	11	Weakfish	4.6707	4.6707	4.6707	4.6707
2101	103	50	Bonito	.0360	.0360	.0360	.0360
2101	103	51	Crevalle Jack	.0130	.0130	.0130	.0130
2101	103	52	Gr. Amberjack	.0530	.0530	.0530	.0530
2101	103	54	Blue Runner	.0130	.0130	.0130	.0130
2101	104	12	Tuna	.0110	.0110	.0110	.0110
2101	104	13	Swordfish	.0520	.0520	.0520	.0520
2101	104	14	Shark	.0383	.0383	.0383	.0383
2101	104	15	Dogfish	.0074	.0074	.0074	.0074
2101	105	17	Summer Flounder	.0180	.0180	.0180	.0180
2101	105	56	Southern Flounder	.0068	.0068	.0068	.0068
2101	105	251	Dusky Flounder	.0130	.0140	0.0000	0.0000
2101	105	251	Windowpane	.0205	.0155	.0117	.0015
2101	106	11	Weakfish	.0030	.0030	.0030	.0030
2101	106	28	Tilefish	.0750	.0750	.0750	.0750
2101	106	35	Atlantic Croaker	.0150	.0150	.0150	.0150
2101	106	36	Banded Drum	.0347	.0933	.0121	.0013
2101	106	36	Star Drum	.0125	.0290	.0467	.0177
2101	106	37	Spot	.0220	.0220	.0220	.0220
2101	106	40	Eel	.0011	.0011	.0011	.0011
2101	106	46	Spotted Sea Trout	.0420	.0420	.0420	.0420
2101	106	48	Salt Catfish	0.0000	.0120	.0120	0.0000
2101	106	58	Red Drum	.0014	.0014	.0014	.0014
2101	106	59	Black Drum	.0036	.0036	.0036	.0036
2101	106	60	Porgy	.3900	.3900	.3900	.3900
2101	106	61	Plorida Pompano	.0130	.0130	.0130	.0130
2101	106	62	Grunt	.0220	.0220	.0220	.0220
2101	106	63	Pinfish	.0076	.0076	.0076	.0076
2101	106	64	Kingfish	.0056	.0056	.0056	.0056
2101	106	64	Kingfish	.0082	.0136	.0082	.0027
2101	106	68	Snowy Grouper	0.0000	.0059	.0089	0.0000
2101	106	71	Spotted Hake	.0160	.0160	.0160	.0160
2101	106	91	Sand Perch	.0120	.0263	.0263	.0120
2101	106	116	Skate	.0206	.0058	.0058	.0206
2101	106	116	Stingray	.6386	.0420	.0420	.6386
2101	106	131	Round Scad	.0073	.0439	.0436	.0073
2101	106	134	Inshore Lizardfish	.0139	.0139	.0139	.0139
2101	106	142	Southern Killifish	.0060	.0060	.0060	.0060
2101	106	199	Ariomma Bondi	.0028	0.0000	.0028	.0028

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ZONE 21 - JACKSONVILLE, FL (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA for nrdam/cme model

Jacksonville Port & Subzone	Species Category	(Port 21) Species Code	Species Name	Wildlife Abundance Tables Fish & Shellfish Grams per Square Meter Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
2101	106	199	Cobia	.0170	.0061	.0061	.0170
2101	106	199	Roundfish	.0329	.0025	.0025	.0329
2101	106	199	Sharksucker	.0018	.0005	.0005	.0018
2101	106	199	Synodus Foeteus	.0130	.0257	.0257	.0130
2101	106	239	Atlantic Bumper	0.0000	.0980	.0980	0.0000
2101	107	216	Scallop	.0620	.0620	.0620	.0620
2101	107	299	Other Mollusc	.0120	.0120	.0120	.0120
2101	108	215	Shrimp	.0840	.0840	.0840	.0840
2101	108	217	Crab	.0006	.0006	.0006	.0006
2101	108	298	Decapod, Stomapod	.2001	.2530	.1910	.0879
2101	109	207	Blue Crab	.0080	.0080	.0080	.0080
2102	101	1	American Shad	.4800	.2400	0.0000	.2400
2102	102	3	Menhaden	.1800	.1500	.1500	.1700
2102	102	5	Butterfish	0.0000	0.0000	.0060	.0030
2102	102	33	Spanish Mackerel	0.0000	.0230	.0090	.0050
2102	102	42	Atl. Thread Herring	0.0000	.0410	.1300	.0700
2102	102	43	Anchovy	0.0000	.0300	.0600	.0300
2102	103	8	Bluefish	0.0000	.0070	.0040	.0020
2102	103	9	Striped Bass	.1000	.1900	.1900	.1900
2102	105	17	Summer Flounder	.1500	.9500	.8200	.8800
2102	106	35	Atlantic Croaker	3.5000	3.5000	3.5000	3.5000
2102	106	36	Drum	0.0000	0.0000	.0015	.0018
2102	106	37	Spot	1.3000	1.3000	1.3000	1.3000
2102	106	46	Spotted Sea Trout	1.2000	1.3000	1.5000	1.2000
2102	106	48	Sea Catfish	.0580	.1800	0.0000	.0300
2102	107	212	Oyster	.8800	.8800	.8800	.8800
2102	107	213	Hard Clam	.0090	.0090	.0090	.0090
2102	108	209	Blue Crab	10.8000	10.8000	10.8000	10.8000
2102	108	215	Shrimp	1.3000	2.8000	2.4000	1.1000

APPENDIX U

ZONE 21 - JACKSONVILLE, FL (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA for nrdam/cme model

Jacksonville Port & Subzone	Species Category	(Port 21) Species Code	Species Name	Wildlife Abundance Tables Fish & Shellfish Larvae Numbers per Square Meter Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
2101	202	1004	Herring	0.0000	0.0000	0.0000	1.0080
2101	202	1007	Mackerel	.1375	.1375	0.0000	0.0000
2101	202	1044	Mullet	.0166	0.0000	0.0000	.0011
2101	202	1128	Sea Robin	0.0000	1.1000	2.2000	0.0000
2101	202	1199	Larvae	21.0000	10.0000	1.0000	21.0000
2101	203	1008	Bluefish	.0003	.0030	0.0000	0.0000
2101	203	1053	Jack	27.6375	10.0000	0.0000	.0011
2101	204	1012	Bluefin Tuna	.3830	.3830	.3830	.3830
2101	205	1199	Larvae	.5000	1.0000	.1000	1.0000
2101	205	1251	Lefteye Flounder	4.1250	.1833	.1833	.1833
2101	206	1021	Codfish	0.0000	0.0000	.0200	.0200
2101	206	1036	Drum	0.0000	0.0000	.1667	.1833
2101	206	1076	Sea Bass	15.2625	7.0000	0.0000	0.0000
2101	206	1120	Goby	0.0000	0.0000	0.0000	.1833
2101	206	1140	American Eel	0.0000	.0705	0.0000	0.0000
2101	207	1199	Larvae	2.0000	20.0000	2.0000	0.0000
2101	208	1199	Larvae	.0016	.0042	0.0000	0.0000
2102	202	1004	Herring	.6930	.6930	.6930	.6930
2102	202	1042	Atl. Thread Herring	2.1735	.1890	0.0000	.0630
2102	202	1043	Anchovy	1.1025	2.8980	.6300	.1575
2102	202	1121	Blenny	.0945	.0945	.0945	.0945
2102	202	1199	Larvae	1367.0000	651.0000	65.0000	1367.0000
2102	202	1238	Scaled Sardine	.3780	.1260	.0315	.0315
2102	203	1199	Larvae	12.2000	11.6000	.5800	0.0000
2102	205	1199	Larvae	5.0000	5.8000	.5800	5.8000
2102	205	1242	Lined Sole	.1890	.2520	.0315	0.0000
2102	206	1046	Spotted Sea Trout	.0630	.0630	.0315	.0315
2102	206	1073	Mojarras	.0315	.0315	.0315	.0315
2102	206	1120	Goby	1.1340	1.0395	.1575	.0945
2102	206	1199	Callionymus Pauciadiatus	1.7010	.6930	.2205	.5670
2102	206	1199	Larvae	.3780	.3780	.3780	.3780
2102	206	1199	Larvae	3.7500	23.1000	7.7000	15.4000
2102	206	1241	Pigfish	.0945	.0315	.6615	.4095
2102	206	1266	Archosargus Rhomboidalis	.3780	.1575	.0630	.0315
2102	207	1199	Larvae	20.0000	200.0000	20.0000	0.0000
2102	208	1199	Larvae	.0160	.0420	0.0000	0.0000

APPENDIX U

ZONE 21 - JACKSONVILLE, FL (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA for nrdam/cme model

Jacksonville Port & Subzone	Species Category	(Port 21) Species Code	Species Name	Wildlife Abundance Tables Birds Numbers per Square Kilometer Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
2101	111	511	Dabbling Duck	245.0000	0.0000	245.0000	490.0000
2101	111	512	Coot, Gallinule	160.0000	0.0000	160.0000	320.0000
2101	111	513	Goose	13.5000	0.0000	13.5000	27.0000
2101	111	514	Swan	27.0000	27.0000	27.0000	27.0000
2101	111	516	Common Loon	.0400	0.0000	.0700	.3500
2101	111	516	Red Throated Loon	.0100	0.0000	0.0000	0.0000
2101	112	571	Shorebirds	35.8000	17.3000	17.3000	158.2000
2101	113	531	Bonaparte's Gull	.0700	0.0000	0.0000	.5700
2101	113	531	Glaucous Gull	0.0000	0.0000	0.0000	.0100
2101	113	531	Gull	0.0000	0.0000	0.0000	.0400
2101	113	531	Herring Gull	.2200	0.0000	.1100	.3200
2101	113	531	Laughing Gull	.2500	.0200	.2700	0.0000
2101	113	531	Laughing Gull	.2500	.0200	.2700	0.0000
2101	113	532	Black Legged Kittiwake	0.0000	0.0000	0.0000	.1100
2101	113	533	Brown Noody	0.0000	0.0000	.0100	0.0000
2101	113	533	Common Tern	.0300	.0600	2.1800	0.0000
2101	113	533	Forster's Tern	0.0000	0.0000	.0100	0.0000
2101	113	533	Least Tern	0.0000	.0100	0.0000	0.0000
2101	113	533	Razor Bill	0.0000	0.0000	0.0000	.0200
2101	113	533	Royal Tern	.0200	.0200	.0100	10.0000
2101	113	533	Sandwich Tern	0.0000	.0100	.0100	0.0000
2101	113	534	Black Tern	.0100	.0200	.6500	0.0000
2101	113	534	Manx Shearwater	0.0000	0.0000	.0100	.0200
2101	113	534	Shearwater	.0200	.0700	.4600	.1400
2101	113	534	Tern	.0300	.1900	.2100	.0100
2101	113	535	Jaeger	0.0000	0.0000	.0100	0.0000
2101	113	535	Parasitic Jaeger	.0200	0.0000	.0100	0.0000
2101	113	535	Pomarine Jaeger	0.0000	0.0000	.0300	.0200
2101	113	536	Northern Fulmar	0.0000	0.0000	0.0000	.0400
2101	113	542	Phalarope	0.0000	.0100	0.0000	3.2700
2101	113	542	Red Phalarope	0.0000	0.0000	.0200	5.9000
2101	113	542	Red-Necked Phalarope	0.0000	0.0000	.2200	2.2200
2101	113	547	Gannet	.6600	0.0000	0.0000	0.0000
2101	113	599	Other	0.0000	.1900	1.4800	.0300
2102	111	511	Dabbling Duck	245.0000	0.0000	245.0000	490.0000
2102	111	512	Coot, Gallinule	160.0000	0.0000	160.0000	320.0000
2102	111	513	Goose	13.5000	0.0000	13.5000	27.0000
2102	111	514	Swan	27.0000	27.0000	27.0000	27.0000
2102	112	571	Shorebirds	35.8000	17.3000	17.3000	158.2000

APPENDIX V

TAMPA, FL

(ZONE 22)

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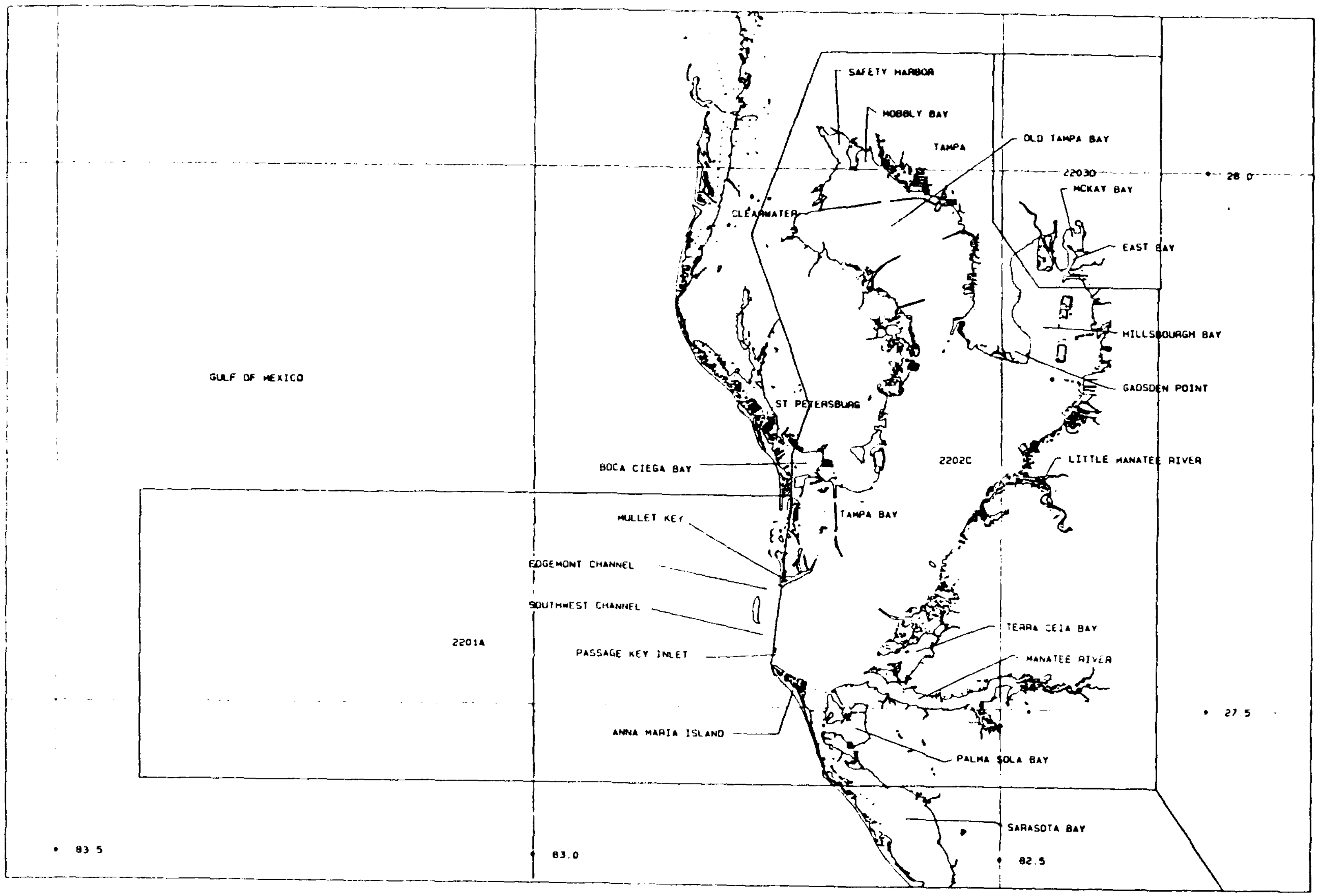
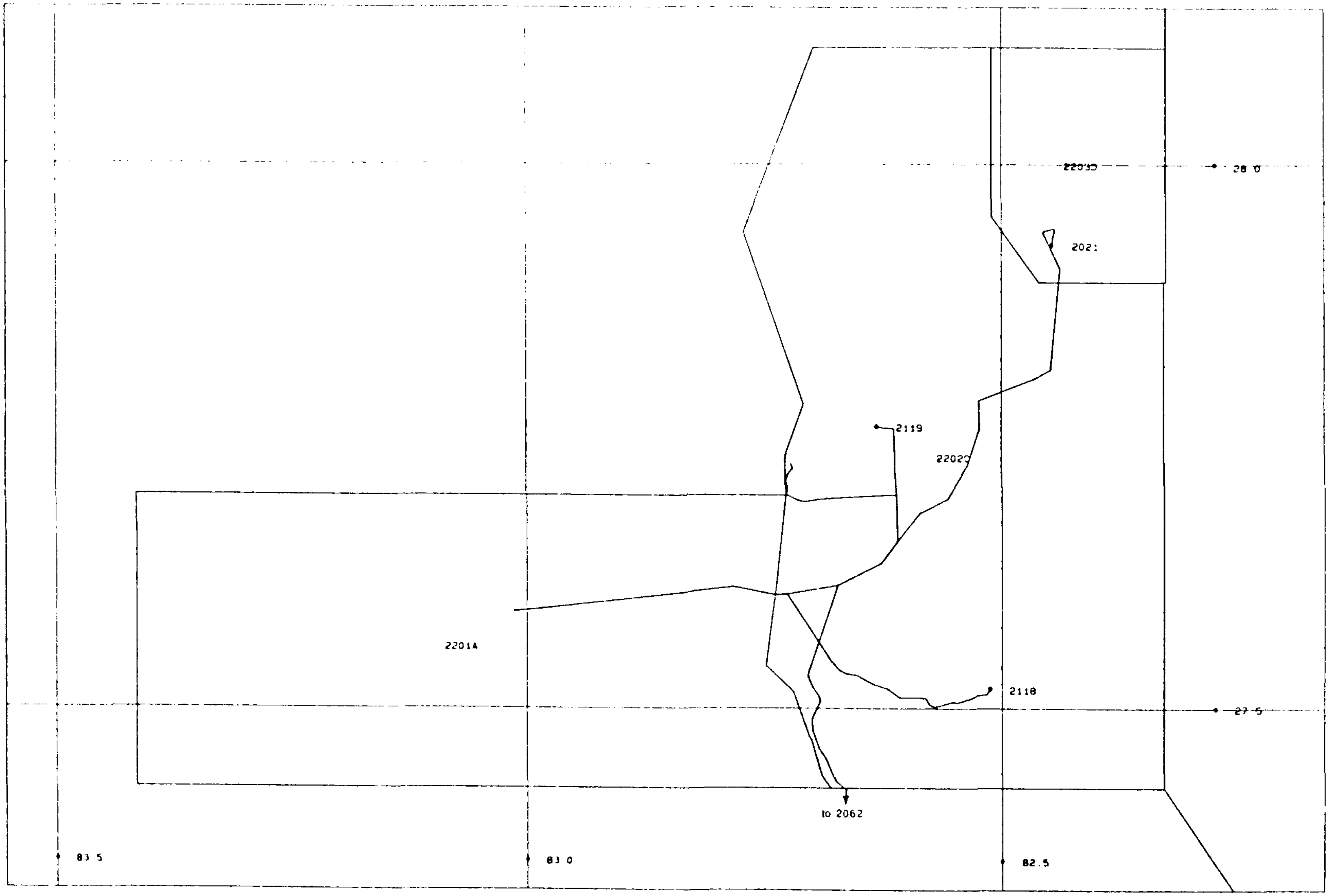
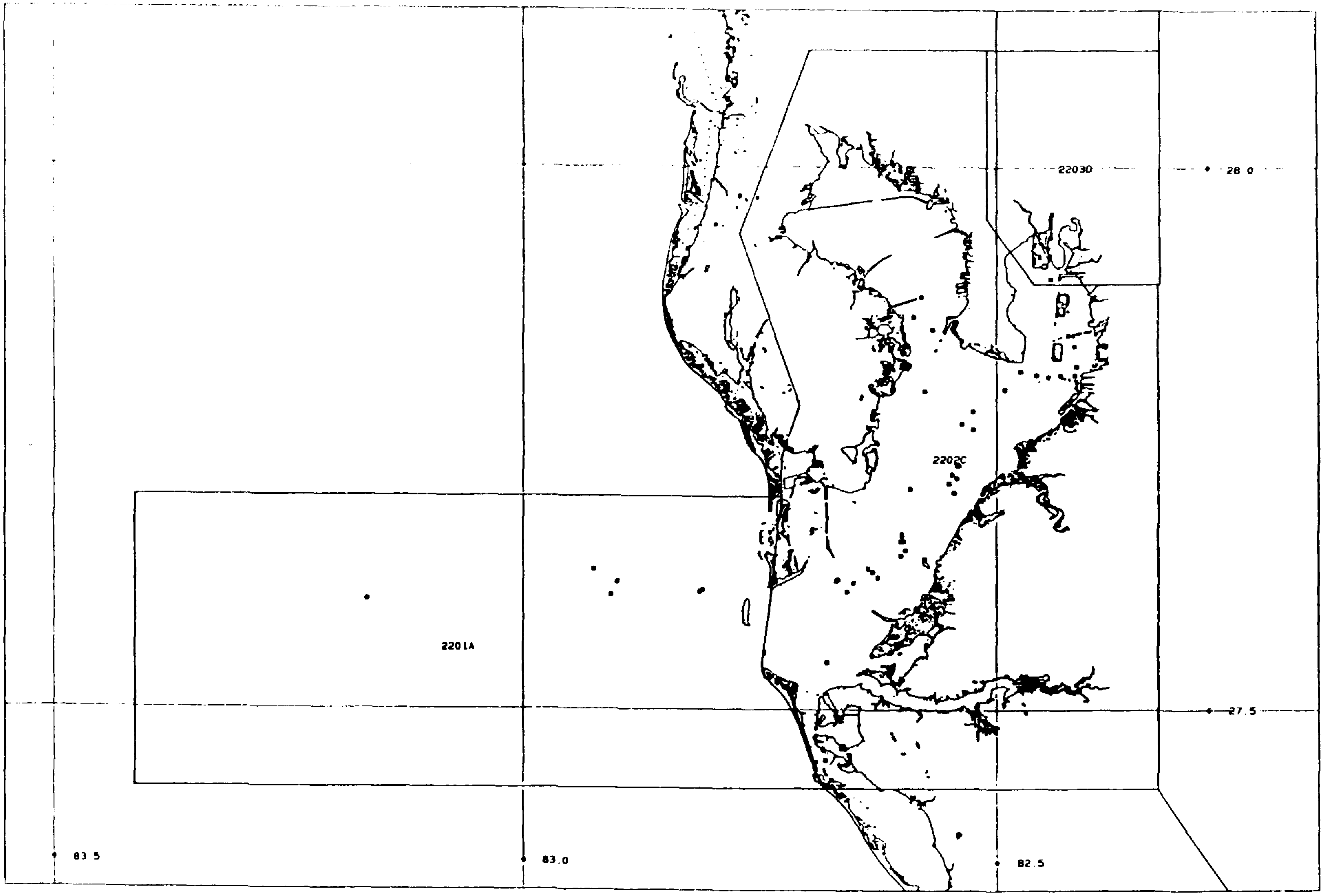
STUDY ZONE MAPS



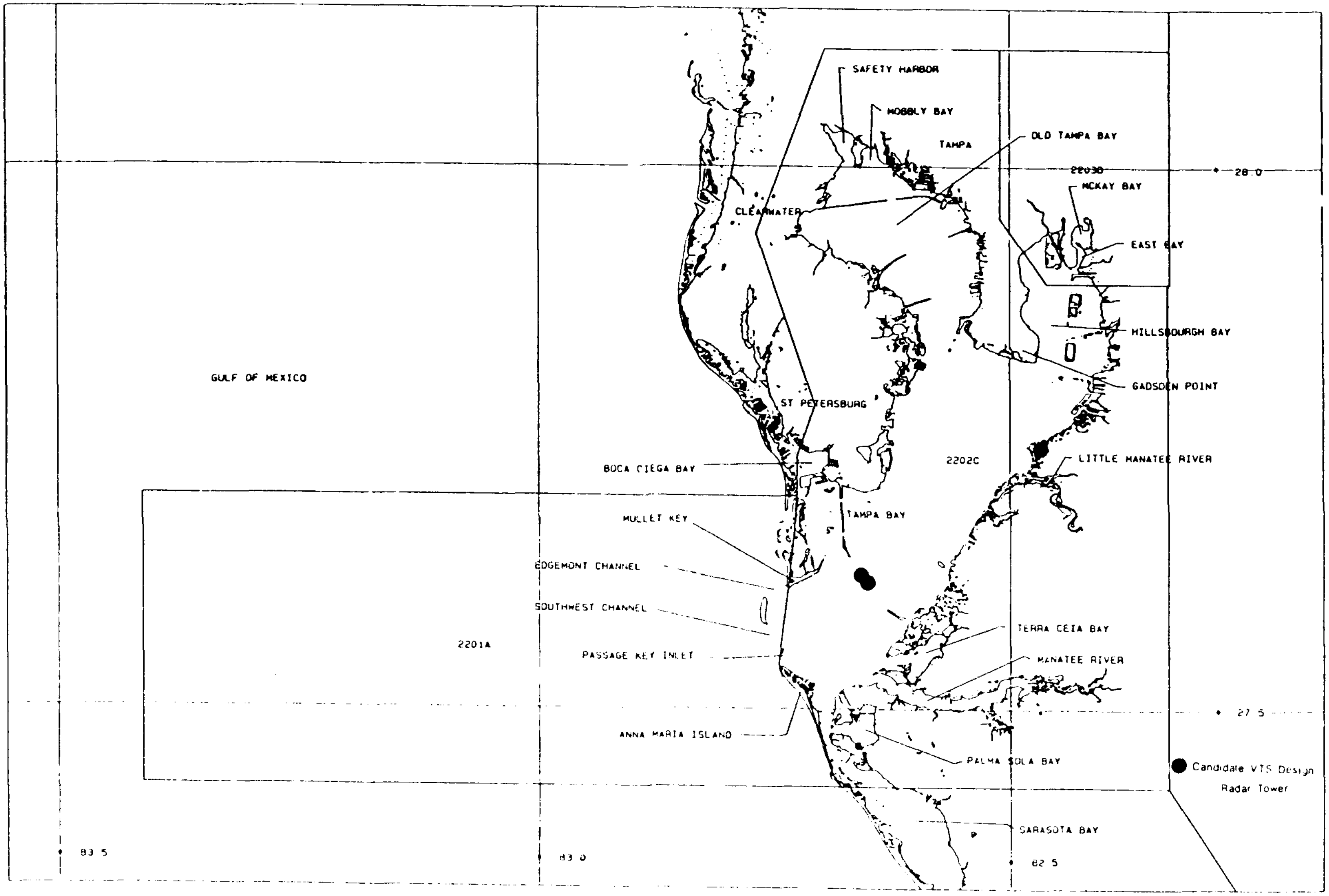
ZONE 22 - TAMPA, FL - ZONE AND SUBZONE BOUNDARIES



ZONE 22 - TAMPA, FL - DOMINANT VESSEL ROUTES AND COE WATERWAY CODES



ZONE 22 - TAMPA, FL - BASE PERIOD (10 YEAR) VESSEL CASUALTIES



ZONF 22 - TAMPA, FL - CANDIDATE VTS DESIGN RADAR LOCATIONS

CANDIDATE VTS DESIGN REPORT

FOR

TAMPA, FL

(ZONE 24)

Prepared for:
U.S. Department of Transportation
Research and Special Programs Administration
John A. Volpe National Transportation Systems Center
Cambridge, MA 02142

Prepared by:
NAVCOM Systems, Inc.,
7203 Gateway Court
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July 1991

OVERVIEW

The Candidate VTS Design described in this appendix is one of 23 developed for all the study zones included in the study. This appendix documents the task performed, under Contract DTRS-57-88-C-00088 Technical Task Directive 13, as an integral part of the total Port Needs Study. The ultimate product of this task effort is an informed preliminary technical assessment of the approximate cost to the Federal Government to implement and operate a state-of-the-art VTS system. This appendix does not contain a comprehensive definition of the VTS operating requirements nor does it propose a final VTS specification suitable for implementation.

In order to consistently estimate the life cycle costs of a VTS system in each of the study zones, a "Candidate VTS Design" has been defined for each study zone using a uniform set of design criteria. Each study zone Candidate VTS Design is a composite of generic modules selected from a master list of 18 state-of-the-art surveillance modules, communications and display technology. Among the surveillance modules in the master list are several levels of technical performance from which the selection is made for application to each study sub-zone to address the local navigational surveillance needs and conditions. The Candidate VTS Design in each study zone represents a consistent application of the surveillance modules at the sub-zone level. The sub-zone surveillance technology is subsequently integrated into a total system for the study zone via state-of-the-art communications and display consoles at the Vessel Traffic Center (VTC) in each zone.

The application of the surveillance modules in each sub-zone responds to the technical requirements of that sub-zone as perceived by the study team. The Candidate VTS Design represents a preliminary engineering judgement on the appropriate level of technology in each sub-zone. The Candidate VTS Design may be considered as an informed judgement made by the contractor study team for the sole purpose of developing cost estimates that are consistent across the 23 study zones and suitable for benefit/cost comparisons among the study zones and initial budget planning and implementation priorities. The approach used to calculate VTS system costs for all 23 study zones is found in Volume III, Technical Supplement.

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TAMPA VTS DESIGN

1.0 SCOPE

This report includes a port survey and a VTS design for Tampa, Florida. The port survey is based on a review of all pertinent literature including navigational charts. The methodology used to produce the VTS design entails coupling the problems identified in the port survey with solutions offered by state-of-the-art technology as identified in the VTS Technology Survey, November 1990. When possible, technological advances which permit manpower reductions are applied. Not all VTS problems are amenable to strictly technological solutions; some require changes in procedures and/or enforcement. These situations are identified where they occur.

2.0 TAMPA BAY PORT SURVEY

2.1 INTRODUCTION

This survey report is based exclusively upon review of available literature and examination of the charts for the surveyed area and its approaches. The information thus gained has been evaluated and interpreted based upon the Survey Team's experience as professional mariners and in vessel traffic management systems.

The Survey Area includes all of Tampa Bay, its seaward approaches and the ports served by the Federally maintained channels within it.

The channels within the study area are generally narrow and the facilities located in the upper reaches of Tampa Bay are over 20 miles from the seaward entrance. Overall traffic volume is moderate, but the narrowness of the waterways introduce a number of traffic management concerns, chief of which is the avoidance of meetings at critical points like turns and very narrow reaches.

In 1987 Tampa Bay ranks tenth among United States ports in the handling of refined petroleum products--gasoline, jet fuel and fuel oil (Reference 1).

Tampa Bay is environmentally sensitive and its shoreline outside of port areas has been heavily developed as residential areas. A major spill would thus impact both wildlife and human habitat.

2.2 OVERVIEW OF THE PORT

Climate within the Survey Area consists of mild winters and warm summers. Conditions are generally benign except for the prevalence of summer thunder storms and the occasional hurricane. The thunderstorms are of importance to vessel traffic management. They occur on an average of 91 days per year, mostly during summer

afternoons, and can be accompanied by strong gusty winds which pose handling problems for high-sided or lightly laden ships.

Poor visibility (less than 0.25 miles) occurs an average of 24 days per year, primarily during the period November through April (Reference 2). Foggy periods are most likely to occur in the early mornings.

The mean diurnal range of tide is 2.3 feet but is strongly affected by winds. Strong offshore winds can lower Tampa Bay by as much as four feet, and strong onshore winds can raise the level by the same amount. Winds also affect the times at which high and low tides occur. Tidal velocities seldom exceed two knots, but can also be varied by wind conditions.

Pilotage is compulsory for all foreign vessels and for U. S. vessels under register. Pilotage is optional for U. S.-flag ships in the coastwise trade drawing over 7' and which have on board a Federally licensed pilot.

Pilot service is provided by two organizations, the Tampa Bay Pilots and the Tampa Bay Tri-County Pilots Association. Both pilots associations monitor VHF-FM CH10, CH12 and CH16 continuously. The Tri-County Pilots Association also monitors CH11 and CH13. Both associations' pilot boats are equipped with CH10, CH11, CH12 and CH16. The boats work on CH10, CH11 and CH12.

Ships entering by Egmont Channel are boarded between Tampa Bay Lighted Whistle Buoy T and Egmont Channel Lighted Bell Buoy 2. Ships entering through Southwest Channel are boarded between Southwest Channel Buoy 2 and Lighted Bell Buoy 3. During strong NW winds, pilots board inside Egmont Key. Departing ships drop pilots at the same locations.

A Federal project provides for depths of 36 feet from the Gulf of Mexico through the entrance and 34 feet from there to the head of deep-draft navigation. Widths of the project channels vary and chart tabulations should be consulted for specific dimensions.

The approach from seaward is not difficult and is well marked by aids to navigation. Loran-C coverage is good. There are few offshore dangers, chief of which is Palantine Shoal, about five miles W of Egmont Key. Inshore, the Federal channels are bordered by unmarked spoil areas covered to various depths to ten feet or less. The narrowness of the channels pose significant traffic management concerns, which are reflected in the rather complicated and extensive regulations governing movement within the area.

2.3 EXISTING TRAFFIC MANAGEMENT

2.3.1 Tampa Bay Navigational Guidelines

The U. S. Coast Guard Captain of the Port (COTP) and the Tampa Bay Marine Advisory Council have formulated a set of guidelines for vessels using Tampa Bay (Reference 3). While not binding in a legal sense, the "Guidelines" establish a set of rules governing critical aspects of vessel movement. These include:

- o Effectively limiting the draft of ships entering or leaving Tampa Bay to 33'6".

- o Limiting movements during restricted visibility to periods when "...at least two sets of channel buoys are visible ahead."

- o Encouraging movement arrangements be made with agents via landline, using radiotelephone for that purpose only in urgent situations.

- o Establishing rules of precedent for the movement of ships. Under the "Guidelines", outbound ships have priority of movement except under specific circumstances. These are:

  - oo When movements of two ships which are restricted by tide conflict, those ships should "split the time", with no more than two ships making the same tide.

  - oo If a vessel having priority of movement cannot enter Tampa Bay or depart her berth within 30 minutes of the established time that vessel loses priority.

  - oo Ships should adjust speeds as necessary to insure that meetings occur at the safest possible locations. Vessels least affected by current and winds should give way to others and light-draft ships should give way to deep-draft ones if conditions permit.

2.3.2 Security Broadcast System, Tampa Bay

The COTP has established a system of VHF-FM Channel 13 Broadcast Reporting Points designed to "give masters and pilots real-time information" (Reference 4) about traffic in Tampa Bay. All vessels subject to the Vessel Bridge-to-Bridge Radiotelephone Regulations (33CFR26) are asked to voluntarily participate. Seventeen reporting points have been designated and at or when approaching them participating vessels are asked to make a Security Call on CH13 announcing the name of the ship, the location, direction of movement and the next waterway or channel the vessel will transit.

Tugs with tows are asked to also report the nature of the tow. Reporting points are:

No. 1: Inbound traffic, between Tampa Bay Lighted Whistle Buoy T and Egmont Channel Lighted Whistle Buoy 1.

No. 2: Inbound traffic, when approaching Egmont Channel Lighted Whistle Buoy 9.

No. 3: Inbound traffic, when approaching Mullet Key Channel Lighted Buoy 19.

No. 4: Inbound traffic, abeam Southwest Channel Entrance Lighted Bell Buoy 1.

No. 5: Inbound traffic, When east of Egmont Key approaching Mullet Key Channel entrance.

No. 6: Outbound traffic, when leaving Mullet Key Channel, bound for Egmont Channel or Southwest Channel.

No. 7: Inbound traffic, when abeam Mullet Key Channel Lighted Buoy 23.

No. 8: Inbound and outbound traffic, at the junction of Tampa Bay Cut A Channel and Cut B Channel.

No. 9: Inbound and outbound traffic, at the junction of Tampa Bay Cut B Channel and Manatee Channel.

No. 10: Inbound and outbound traffic, off the entrance to St. Petersburg Channel.

No. 11: Inbound and outbound traffic, junction of Tampa Bay Cut C Channel and Cut D Channel.

No. 12: Outbound traffic, when entering Tampa Bay Cut F Channel.

No. 13: Inbound traffic, when entering Tampa Bay Cut G Channel.

No. 14: Inbound traffic, when entering Gadsden Point Cut Channel.

No. 15: Inbound traffic, when entering the channel to Big Bend.

No. 16: Inbound traffic, when entering Alafia River Channel.

No. 17: Inbound traffic, when in Hillsborough Bay Cut C Channel north of the junction with the Alafia River.

Additional calls are encouraged, depending upon weather conditions and under special circumstances such as changing position or length of tow or before an unusual maneuver. Vessels should also make a Security Call immediately before departing berth, or when approaching an anchorage. Chartlets showing reporting points and additional information is available from the USCG Marine Safety Office, Tampa.

2.3.3 Voluntary Agreement for Determining Acceptable Combined Beamwidths in Tampa Bay

Because of the narrow channels which constitute most of the port area east of the Sunshine Skyway Bridge the primary commercial maritime users of Tampa Bay have developed additional guidelines to help masters and pilots to determine the safest locations for meeting and passing (Reference 5).

Basically, the guidelines state that under ideal conditions and in daylight, it is acceptable for ships with a combined "effective beam width" of not over 212' to meet or overtake in a channel 500' wide or wider. "Ideal conditions" mean that the vessels involved have good inherent maneuverability, are properly loaded so that handling is not degraded and weather and current conditions are such that they have little or no effect. Additional restrictions are that ships may not meet at turns and that vessels of over 100' effective beam do not meet in 400' channels. When ideal conditions do not exist, or when tows are involved, beams are artificially increased by arithmetic factors which take existing conditions into account.

There are other special rules which apply. Carriers of anhydrous ammonia, ships over 106' in beam, vessels carrying dangerous cargoes, dead ships and those with casualties to equipment which might impinge upon their ability to maneuver may move only at the specific direction of the COTP. In addition, ships with beams over 100' may move between berths in the upper Bay (where channel widths are 400') only as directed by the COTP.

The Tampa Bay Port Authority has established a reporting station to insure that all moving ships have the information needed to conform to the Agreement. The reporting station has its own callsign, and guards VHF-FM CH9 and CH16.

All ships are required to provide to the reporting station the following information 24 hours in advance of arrival or departure.

- o Name, location and intentions.

- o Effective beam width and draft.

- o Inbound ships, ETA Sunshine Skyway Bridge and ETA at berth.

- o Outbound ships, ETD berth and ETA at Sunshine Skyway Bridge.

- o Radio channels guarded and/or landline contact.

In response to the initial report the reporting station provides the following information:

- o Names, effective beams, drafts, and destination of ships which will be met during the inbound or outbound transit.

- o The VHF-FM channels or landline contact for communicating with those ships.

Vessels are asked to make mutually acceptable arrangements to adjust speeds and movements so as to comply with the guidelines. If suitable agreement cannot be achieved, both parties should immediately contact the COTP for resolution. The COTP will then direct movements in accordance with the guidelines. The COTP guards Channel 13 for this purpose.

2.3.4 Safety Zones

The COTP establishes fixed and moving safety zones around ships carrying anhydrous ammonia and liquified petroleum gas while they are underway or moored within Tampa Bay.

2.4 VESSEL TRAFFIC

In 1987 the port facilities in Tampa Bay handled 44.3 million tons of seaborne cargo, 8.7 million tons of which consisted of petroleum products (gasoline, jet fuel and fuel oil). That year there were 936 tanker movements within Tampa Bay and 835 movements of petroleum-carrying barges (Reference 6). A "significant amount" of recreational boating traffic is reported within the area, including along the ICW. Additional traffic statistics were not provided.

2.5 ENVIRONMENTAL SENSITIVITY

The shorelines of Tampa Bay are highly sensitive, particularly inshore of the Barrier Islands and other areas of sheltered tidal flats, marshes and mangrove swamps. These areas are home to two endangered species, the American alligator and the manatee. Special regulations govern vessel movements in manatee areas and the Coast Pilot should be consulted.

The "Worst Case" pollution scenario is a major spill of petroleum product or hazardous chemicals near the Sunshine Skyway Bridge, coupled with a flood tide and strong onshore wind.

2.6 PORT Sub-Zone

The study area was examined to determine appropriate sub-zones, using the methodology based upon the "confined-complex", "open-complex", "confined-simple" and "open-simple" system employed by the Canadian VTS Study in 1984 (Reference 7). Briefly stated, "open" and "confined" address the influence of geography upon a ship's ability to maneuver; and "simple" vs "complex" is descriptive of the nature of the interactions between ships within those geographic areas. This basic matrix was overlaid by a subjective assessment of appropriate traffic management/risk amelioration measures in order to derive sub-zones within which VTS needs are homogeneous, or nearly so.

2.6.1 Sub-Zone I -- Gulf Offshore Approaches (NOAA Chart 11006)

Sub-Zone I consists of the Gulf of Mexico Approaches to the Tampa Bay area lying seaward of a line drawn due west from the shoreline to 27^0-30'N 83^0-10'W, thence to 27^0-44.3'N 83^0-10'W and eastward from that point to the shoreline.

The sub-zone limits were deliberately positioned to the west of the Western Tampa Fairway Anchorage, as described in 33CFR166.200. Sub-Zone I constitutes a <u>reporting area</u> from which ships provide to a VTC information required by the current "Voluntary Agreement for Determining Acceptable Combined Beam Widths in Tampa Bay". No other traffic management elements are required or desired.

The sub-zone is "open-simple."

2.6.2 Sub-Zone II -- Inshore Approaches (NOAA Chart 11412)

Sub-Zone II lies inshore of the inshore boundary of Sub-Zone I (a line drawn due west from the shoreline to 27^0-30'N 83^0-10'W, thence to 27^0-44.3'N 83^0-10'W and eastward from that point to the shoreline) and seaward of the Tampa Bay COLREG Demarcation Lines for Egmont Channel, Southwest Channel, Bunces Channel and Pass-a-Grille Channel.

The sub-zone includes the Eastern and Western Tampa Fairway Anchorages, the pilot boarding areas for Egmont and Southwest Channels, the eastern terminus of the Tampa Safety Fairway and the junction of Egmont and Southwest Channels.

Sub-Zone management requirements are primarily keyed to the queuing of inbound traffic to prevent meetings in narrow or critical portions of the channels east of the Sunshine Skyway Bridge, and to the safe and smooth flow of traffic. The ability to exercise control of the Fairway Anchorages, if necessary, and to adjust the speeds and times of entry of inbound shipping are needed. Navigational assistance should be available, if required, particularly when strong NW winds require pilots to board inshore of

Egmont Key. Information about meteorological and tidal conditions throughout Tampa Bay also form input to management decisions.

The sub-zone is considered "confined-simple."

2.6.3 Sub-Zone III -- Tampa Bay (NOAA Charts 11412, 11413 and 11414)

The sub-zone lies inshore of the limits of Sub-Zone II (the Tampa Bay COLREG Demarcation Lines for Egmont Channel, Southwest Channel, Bunces Channel and Pass-a-Grille Channel) to the head of deep-draft navigation in the Project channels. Minor channels are excluded by the following boundary lines:

- o Anna Marie Sound and the Manatee River: By a line between the easternmost point on School Key and Terra Ceia Point.

- o The Tierra Verde-Pinellas Point Area: By a line between the easternmost point on Mullet Key, Intracoastal Waterway Daybeacon 2, the Rear Range of the Cut J Range, and thence due west to the shoreline.

- o Old Tampa Bay: By the Gandy Bridge.

- o Minor waterways on the southwest shore of Tampa Bay which are not accessible to commercial traffic and for which the aids to navigation are privately maintained are also excluded.

The sub-zone includes all of the port facilities and Project channels within Tampa Bay, the Explosives and Quarantine Anchorages, the intersections with the ICW and that portion of the main channel shared by both ICW and deep-draft traffic. The VTS must manage traffic to avoid unacceptable meetings as well as providing general movement and traffic advice. Navigational assistance is limited to the along-track component because of the narrowness of the waterways. Accurate real-time information about meteorological and tidal conditions are important inputs to management decisions. The VTS should be capable of controlling the anchorages, if required. Real-time tidal and meteorological data is required because of the effect winds may have on the tidal cycle and water depths, and its effect on ship handling.

The sub-zone is "confined-complex."

2.7 PROBLEM AREA IDENTIFIERS

2.7.1 PAI II-1. The Fairway Anchorages

Two fairway anchorages exist immediately north of the sea buoy. The anchorages provide one resource useful in management of the queuing of inbound traffic. The anchorages are large, relative to identified number of ship movements and therefore real-time

surveillance may be required only in exceptional circumstances. Under normal conditions reporting of movements to and from anchor should suffice.

2.7.2 PAI II-2. Egmont Channel Pilot Boarding Area

Pilots board and are normally dropped between Tampa Bay Lighted Whistle Buoy T and Egmont Channel Lighted Bell Buoy 2. A surveillance capability will permit movement management advice as required to minimize or avoid traffic conflicts in the pilot boarding area and, for inbound ships, within Tampa Bay as well. Navigational assistance may also be required, particularly when strong NW winds require pilots to board inbound ships east of Egmont Key.

2.7.3 PAI II-3. Southwest Channel Pilot Boarding Area

Pilots board and are normally dropped between Southwest Channel Buoy 2 and Southwest Channel Lighted Bell Buoy 3. A surveillance capability will permit movement management advice as required to minimize or avoid traffic conflicts in the pilot boarding area and, in the case of entering ships, within Tampa Bay as well. Navigational assistance may also be required, particularly when strong NW winds require pilots to board inbound ships east of Egmont Key.

2.7.4 PAI III-1. Mullet Key

The area immediately to the west of Mullet Key Channel is where pilots are picked up and dropped during conditions of strong NW winds and is also the junction point of the Egmont, Southwest and Mullet Key Channels. Real-time surveillance will enable the VTS to provide movement management and navigational assistance as required.

2.7.5 PAI III-2. Sunshine Skyway Bridge

The vicinity of the Sunshine Skyway Bridge is and will be the site of construction activity for a number of years. The movement of shipping may from time to time be coordinated with construction and demolition work. Just west of the Bridge ICW traffic joins and departs the mail channel to the south. Real-time surveillance will enable the VTS to provide movement management advice as required.

2.7.6 PAI III-3. Explosives Anchorage

The Explosives Anchorage lying north of Cut A is an important traffic management resource and the VTS should have the capability to manage it when required. Real-time surveillance may be necessary only in exceptional circumstances. Under normal conditions reporting of movements to and from anchor should suffice.

2.7.7 PAI III-4. Port Manatee Junction

The Port Manatee Junction includes the juncture of Cut B and the Port Manatee Channel and the point between Buoys 3B and 9B where the ICW joins the Main Channel from the north. Traffic movement should be adjusted as required to prevent meetings while a ship is entering or leaving the Port Manatee Channel from Cut B. Movement advice should be provided as required to merge ICW traffic safely and smoothly with deep-draft traffic.

2.7.8 PAI III-5. Interbay Junction

Traffic movement should be managed to prevent meetings at or near the three channel junction south of the Interbay Peninsula.
It should be noted that it is within this PAI that the COTP begins the escort of carriers of anhydrous ammonia.

2.7.9 PAI III-6. Quarantine Anchorage

The Quarantine Anchorage lying south of Gadsden Point Cut is potentially an important traffic management resource and the VTS should have the capability to manage it when required. Real-time surveillance may be necessary only in exceptional circumstances. Under normal conditions reporting of movements to and from anchor should suffice.

2.7.10 PAI III-7. Temporary Explosives Anchorage

The Temporary Explosives Anchorage lying south of Interbay Peninsula is potentially important to traffic management and the VTS should have the capability to manage it wnen required. Real-time surveillance may be necessary only in exceptional circumstances. Under normal conditions reporting of movements to and from anchor should suffice.

2.7.11 PAI III-8. Cut J Turn

Traffic movement should be managed to prevent meetings at or near the turn from Cut G into Cut J. This includes traffic bound to and from St. Petersburg.

2.7.12 PAI III-9. Masters Bayou Channel-Cut K Channel Bifurcation

Traffic movement should be managed to prevent meetings at or near the channel bifurcation. In addition, the Temporary Explosives Anchorage lying north of the junction is potentially important to traffic management and the VTS should have the capability to manage it when required. Real-time surveillance may be necessary only in exceptional circumstances. Under normal conditions reporting of movements to and from anchor should suffice.

2.7.13 PAI III-10. Hillsborough Bay Cut C Junctions

Traffic movement should be managed to prevent meetings at or near the two junctions with channels serving the Apollo Beach and Alafia River facilities.

2.7.14 PAI III-11. Pendola Point

Traffic movement should be managed to prevent meetings at or near the junctions at or near Pendola Point.

3.0 TAMPA VTS DESIGN

3.1 INTRODUCTION

A detailed survey of the port of Tampa Bay is the basis for this design. An approach to costing VTS systems is outlined in Vol. III, Technical Supplement and a method of categorizing surveillance sensors into "modules" has also been developed. These modules are defined in terms of cost and performance and are to be applied to all VTS designs in this study. The applicability of Automatic Dependent Surveillance (ADS) technology is also discussed in this report. The three sub-zones defined in the harbor survey remain the same.

Traffic management requirements for each sub-zone are developed from PAI analysis. Table 3-1 lists in tabular form a summation of the problems identified and the management required by sub-zone.

The hardware and software selected for this design provide the level of surveillance justified by the problems identified in each sub-zone. A secondary consideration is to locate all VTS assets so that they are sufficient for the sub-zone in question and can contribute to adjoining sub-zones to achieve maximum usage. All specific equipments are then selected based on perceived surveillance requirements and overall VTS system architecture.

3.1.1 VTS Design Approach

The choice of surveillance sensors is dependent on the VTS mission. For the purposes of this design, the VTS mission is defined as that which insures the safety of navigation and the protection of the environment. In order to accomplish this mission, mandatory participation of all vessels over 20 meters is essential. The Vessel Traffic Center (VTC) must provide navigation safety advice to all vessels. The VTS in the United States will have no facilitation of commerce role nor will it offer piloting assistance of any kind.

The primary criteria for sel[illegible]ion of adequate surveillance sensors are:

TABLE 3-1. TAMPA BAY, FL PROBLEM AREA IDENTIFIERS

PAI	LOCATION	PROBLEM	MANAGEMENT
I	Gulf Offshore Approaches	Data catchment area for inbound shipping	Have knowledge of ship movement, intentions and characteristics. Enter inbound traffic into database
II	Inshore Approaches	Potential congestion, pilots boarding area. Inbound queuing must be regulated within this sub-zone, with modifications as dictated by weather, tides. Approach may be made without pilots under certain conditions.	Have real-time knowledge of vessel movements. Be able to provide navigational assistance and movement management advice as required.
III	Tampa Bay	Narrow channels where meetings, overtakings must be managed. The potential for localized congestion. Queuing control required, coupled with anchorage management.	Real-time information of ship positions and movement. Provide movement management advice, control anchorages.

- o Percentage of vessels of the desired minimum size detected in designated surveillance areas

- o Percentage of lost tracks

- o Accuracy of the position and track obtained

- o Reliability of the surveillance system

- o Timeliness of the data obtained

- o Ability to interpret and use the data obtained

Secondary criteria are:

- o Cost of the VTS system -- reduction of manpower by the use of technology

- o Expandability -- increased VTS responsibility, area, and/or support of other missions

Active surveillance sensors including radar, communications, and closed circuit television (CCTV) installations are used when detection and tracking of vessels is paramount to providing safety advice. These devices are considered fail safe in that it is known with certainty when they have failed. The performance characteristics of these sensors are known from operational VTS worldwide experience. In this design they are selected to assure that the necessary operational criteria identified for each sub-zone is realized.

Many dependent surveillance techniques are possible. These range from voice radio reporting of required VTS data to automatic position and identification recording devices that can be interrogated from shore known as Automatic Dependent Surveillance (ADS) devices. The position and/or movement reporting form of dependent surveillance is used extensively in existing VTS systems. The major regions of current use are those which do not require active surveillance. To apply ADS technology to a specific sub-zone within a VTS zone the following additional criteria must be considered:

- o The number and class of vessels interacting in the sub-zone and which of these interactions are important to the VTS mission. Obviously all vessel classes of interest must be appropriately equipped. This requires that all vessels of the classes selected which will ever pass through this sub-zone must be equipped with an ADS device. This requirement to detect so many different vessels argues against the use of ADS. In areas where only one class of vessel is of interest, ADS is more easily implemented.

o The interactions or transits to be monitored must not demand that the surveillance be fail safe, i.e. positively detecting failures. This type of surveillance is related to position reporting in that it may not always function or be used properly and the VTS has limited control over its operation.

o It must be determined that if active surveillance is not justified, the additional information obtained from ADS over position reporting is necessary.

o If the class or group of vessels to be monitored is a "controllable" group, ADS can be easily implemented and satisfactory operation more readily achieved. Controllable means a clearly defined subset of vessels, e.g. a specific barge company; vessels carrying a specific cargo, etc.

o The number of different vessels in each class of interest that passes through the sub-zone in question must be determined. This number must be known to accurately estimate the cost of selecting this option for this sub-zone.

o A specific ADS solution for one sub-zone in one harbor may affect all the VTS designs for all the other sub-zones in all the other harbors.

3.1.2 Assumptions

The design of a VTS system for the Tampa VTS zone starts with a set of assumptions based on the detailed survey and other data. These assumptions are as follows:

o As recommended by the IMO, all vessels of 20 meters or more in length are required to participate in the VTS. Participation is defined (at a minimum) as monitoring the VTS frequency and reporting as required.

o The VTS system is implemented with the cooperation and assistance of the port authorities, pilots associations, and marine exchange, if any. The existing facilities, services, and procedures established and operated by these organizations are major elements of an integrated VTS system as defined in the IMO VTS Guidelines.

o The life-cycle of all system hardware is ten years.

3.2 DESIGN DECISIONS (FIGURE 3-1)

3.2.1 General

Examination of the traffic levels, geographical features and identified problem areas in this port led to the overall conclusion that one control sector managed by one watchstander is sufficient.

3.2.2 Hardware Location and Selection

3.2.2.1 Sub-Zone III

Sunshine Bridge	1 Module 1 radar
	1 Module 2 radar
	1 Module 10 VHF
	1 Module 11 VHF
	1 Module 13 VHF
	1 Module 14 HYD
Mangove Point	1 Module 1 radar
	1 Module 10 VHF
Upper Tampa Bay	1 Module 10 VHF

3.2.3 Vessel Traffic Center

The design of the hardware and software should be modern and capable of operating with reduced staff levels and no loss of effectiveness. One watchstander with an integrated data workstation and decision aiding software can effectively manage the activity in this port. This Vessel Traffic Center concept demands that the watchstander be separated from any other harbor/port information requests. The Center must be structured so that such requests are controlled by a bulletin board type interface. One officer-in-charge and one clerk are also required for the proper administration of the facility.

The Vessel Traffic Center is located in Tampa in a location with good visual surveillance of the Bay and entrance. The center is to employ the following equipment:

3.2.3.1 VTS Console

This console provides total data integration from all sensors in all sectors. These data are graphically shown on raster scan, high light level, color displays. A data display is also provided. Console design architecture is general purpose computer based, open architecture, bus organized, allowing operation of the system as a local area network (LAN). Data interchange with other facilities by modem is provided as well as interface with the U.S. Coast Guard standard terminal. The design allows board level modification and expansion. Features of the software and hardware provided are:

Surveillance Modules -Sub Zones	RADAR						ADS			VHF		MET.		HYD.		DF	CCTV		COMMENTS
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
I																			Comms coverage from Sub-Zone III
II																			Required Comms, Radar & Meteorological Sensors are located in Sub-Zone III
III	2	1								3	1		1	1					

FIGURE 3-1. TAMPA BAY, FL SURVEILLANCE SURVEY

- Software written in a high level language.

- Software providing the total integration of data from all VTS sensors.

- Layering of data in at least four layers to be operator selectable.

- The ability to sector data including sector to sector handoff of targets.

- The ability to accept external digital data derived from transmissions of shipboard transponders or other sources and integrate the information with all other sensor data.

- Automatic and/or manual acquisition of radar targets including automatic tracking and target ID assignments. Guard zones with automatic acquisition of all targets entering the zone.

- Several warning levels of vessel interaction designed to direct attention to developing situations rather than a simple CPA alarm strategy.

- Complete vessel monitoring and alarm capability including anchor watch, CPA, TCPA, track history, adjustable target velocity vectors, restricted area penetration and maneuvering monitor is provided. Additional warning and/or alarm features allowed by programming changes in high level language.

- Complete modern color graphics capability with offset and zoom

- Complete harbor navigation aid monitoring capability including buoy position, light status, etc.

- Remote control of all radars and radar interfaces as well as radar data processing including site-to-site integration, clutter suppression, scan conversion and target extraction.

- Complete track projection capability which can predict and/or analyze future interactions based on current position, destination and velocity.

- The capability of constructing a complete vessel data base and interfacing it to the real-time data display from the VTS sensors.

3.2.3.2 Communications Console

This console is capable of remotely operating the proposed transmitting/receiving sites and allowing transmission and monitoring on all required frequencies. The console provides operating positions each to be capable of complete communications control. It is capable of modular expansion if other remote communications sites are added.

3.2.3.3 Supervisor Control and Data Acquisition (SCADA) Equipment

A SCADA capability is provided to the major module level at remote sites so that the watchstander can determine the status of the entire VTS system. A graphic readout is provided in block diagram form indicating operational status of all elements in the system. Security monitoring of remote sites is also included.

3.2.3.4 Recording Equipment

Time synchronized video and audio recording equipment is to be provided. This equipment is capable of recording and playing back the data presented to the VTS watchstander and his reaction to the situation. An extra set of recording equipment is to be installed for redundancy purposes.

3.3 COST ESTIMATES

3.3.1 General

Vol. III, Technical Supplement discusses a generalized approach to estimating VTS system costs. This approach is based on interviews with system designers and purchasers of recently constructed systems. The cost of the Tampa VTS system has been estimated using this approach and is detailed below. The assumptions made in estimating these costs are listed in Paragraph 3.1.2.

3.3.2 Hardware (x $1000)

<u>Vessel Traffic Center</u>	non-recurring	recurring(10-yr)
VTS Console (1 workstation & all software)	500	
Communications console	100	
Recording Equipment	50	
SCADA Equipment (2 radar sites)	200	
Sub-total:	850	400

<u>Sub-Zone I--Gulf Offshore Approaches (NOAA Chart 11006)</u>

Comms coverage from Sub-Zone III.

Sub-Zone II--Inshore Approaches (NOAA Chart 11412)

Required comms, radar and meteorological sensors are located in Sub-Zone III.

Sub-Zone III--Tampa Bay (NOAA Charts 11412, 11413, & 11414)

2 Module 1 radars	620	620
1 Module 2 radar	310	310
3 Module 10 VHF	57	39
1 Module 11 VHF	48	20
1 Module 13 MET	40	5
1 Module 14 HYD	10	2
Sub-total:	1085	996
HARDWARE TOTALS:	1935	1396

3.3.3 Project Totals (x $1000)

Non-recurring

Hardware	$1935
Management, Engineering, etc. (50%) Assumptions: Turnkey system, Procurement by integ.contractor, good manufacturer support, some software provided, System Manual required	968
Installation site integration (20%) Assumptions: Complete installation by contractor, remote access no serious problem, many widespread sites	387
Spares & Training (10%)	194
Civil Engineering 2 remote radar sites, a VTC in Tampa, remote comms and WX sensors installations, land acquisition	1000
PROJECT ESTIMATE:	4484
Data Base Management System	300
TOTAL: (non-recurring)	$ 4784

Recurring (10 year)

Hardware	1396
1 Watchstander x 5 = 5 man/years @ 50K x 10	2500
1 Officer-in-Charge	500
1 Clerk	500
TOTAL: (recurring) (10-year life)	$ 4896
TOTAL 10-YEAR PROJECT COST:	$ 9680

REFERENCES

1. Summary Statistics on Leading U.S. Ports, Center for Marine Conservation, Washington, D.C., 1990

2. United States Coast Pilot, Volume 5, Atlantic Coast: Gulf of Mexico, Puerto Rico, and Virgin Islands, 21st Edition, NOAA, Washington, D.C., 1989, p. T-3.

3. United States Coast Pilot, Volume 5, Atlantic Coast: Gulf of Mexico, Puerto Rico, and Virgin Islands, 21st Edition, NOAA, Washington, D.C.

4. Ibid, p. 120.

5. Ibid, pp. 121-122. The Survey Report summarizes major points of the Agreement; full text should be read before attempting to participate in the system.

6. Summary Statistics on Leading U.S. Ports, Center for Marine Conservation, Washington, D.C., 1990.

7. Final Report, National Vessel Traffic Services Study (TP5965E), Canadian Coast Guard, Ottawa 1984, pp. 89-91.

GLOSSARY

ADS: Automatic Dependent Surveillance

ARPA: Automatic Radar Plotting Aid.

"CONFINED-COMPLEX": a combination of terms relating to the geography and the nature of the interactions between ships. See Final Report National Vessel Traffic Services Study (TP-5965E), Canadian Coast Guard, Ottawa, October 1984, pp.89-91.

"CONFINED-SIMPLE": a combination terms relating to the geography and the nature of the interactions between ships. See Final Report National Vessel Traffic Services Study (TP-5965E), Canadian Coast Guard, Ottawa, October 1984, pp.89-91.

COTP: Captain of the Port

CCTV: closed circuit television

COLREGS LINE: a demarcation line delineating those waters upon which international regulations for the prevention of collisions at sea apply.

CPA: closest point of approach

DBMS: data base management system

DF: direction finder

FAA: Federal Aviation Administration

GIS: Geographic Information System

ICW: Intracoastal Waterway

IMO: International Maritime Organization

KW: Kilowatt

LAN: local area network

LLOYD'S LIST: a listing of all merchant vessels of the world including their physical characteristics. Published by Lloyd's of London.

LNG: liquified natural gas

NOAA: National Oceanic and Atmospheric Administration

"OPEN-COMPLEX": a combination of terms relating to the geography and the nature of the interactions between ships. See Final Report National Vessel Traffic Services Study (TP-5965E), Canadian Coast Guard, Ottawa, October 1984, pp. 89-91.

"OPEN-SIMPLE": a combination of terms relating to the geography and the nature of the interactions between ships. See Final Report National Vessel Traffic Services Study (TP-5965E), Canadian Coast Guard, Ottawa, October 1984, pp. 89-91.

PAI: Problem Area Identifier

PRECAUTIONARY AREA: an area normally an intersection, entrance to, or exit from a traffic separation scheme where vessel interactions are unpredictable

SCADA: Supervisor Control and Data Acquisition

TCPA: time of closest point of approach

TRAFFIC SEPARATION SCHEME: routes incorporating traffic separation to increase the safety of navigation, particularly in converging areas of high traffic density.

VHF: very high frequency

VTC: vessel traffic center

VTS: vessel traffic services

STUDY ZONE INPUT DATA AND OUTPUT STATISTICS

Appendix V Zone 22 Tampa, FL

TABLE 1 Assignment of COE Waterway Codes to Subzones 8/06/91

COE Waterway		Name
Subzone 2201A		
2021	A	TAMPA HARBOR, FLA.
2062	A	INTRACOASTAL WATERWAY, CALOOSAHATCHEE RIVER
2118	A	MANATEE RIVER, FLA.
2119	A	ST. PETERSBURG HARBOR, FLA.
Subzone 2202C		
2021	A	TAMPA HARBOR, FLA.
2021	B	TAMPA HARBOR, FLA.
2062	A	INTRACOASTAL WATERWAY, CALOOSAHATCHEE RIVER
2062	B	INTRACOASTAL WATERWAY, CALOOSAHATCHEE RIVER
2118	A	MANATEE RIVER, FLA.
2118	B	MANATEE RIVER, FLA.
2119	A	ST. PETERSBURG HARBOR, FLA.
2119	B	ST. PETERSBURG HARBOR, FLA.
Subzone 2203D		
2021	A	TAMPA HARBOR, FLA.
2021	B	TAMPA HARBOR, FLA.
2062	A	INTRACOASTAL WATERWAY, CALOOSAHATCHEE RIVER
2062	B	INTRACOASTAL WATERWAY, CALOCSAHATCHEE RIVER

TABLE 2 Base Year 1987 Cargo Tons by Subzone, Commodity, and Vessel Type

Subzone 2201A

Comm. Code	Name	Dry Cargo	Tanker	Dry Cargo Barge Tow	Tanker Barge Tow	Total
1	FARM PRODUCTS	540,731	0	92,555	0	633,286
2	FOREST PRODUCTS	8	0	0	0	8
3	FISHERIES PRODUCTS	6,220	0	0	0	6,220
4	MINING PRODUCTS, NEC	18,299,287	0	1,878,536	0	20,177,823
5	PROC. FOODS & MFTRS, NEC	4,414,973	0	494,200	0	4,909,173
6	WASTE OF MANUFACTURING	177,033	0	36,402	0	213,435
1311	CRUDE PETROLEUM	0	55,418	0	3,938	59,356
1493	SULPHUR, LIQUID	0	3,146,661	0	223,622	3,370,283
2810	SODIUM HYDROXIDE (CAUSTI	66,406	0	0	0	66,406
2811	CRUDE PROD-COAL TAR-PET	36	0	1	0	37
2813	ALCOHOLS	0	8,758	0	530	9,288
2871	NITROGEN CHEM FERTILIZER	0	83,763	0	5,951	89,714
2872	POTASSIC CHEM FERTILIZER	222,761	0	45,585	0	268,346
2911	GASOLINE, INCL NATURAL	0	6,006,943	0	426,892	6,433,835
2912	JET FUEL	0	781,013	0	55,504	836,517
2913	KEROSENE	0	15,578	0	1,107	16,685
2914	DISTILLATE FUEL OIL	0	1,684,037	0	144,440	1,828,477
2915	RESIDUAL FUEL OIL	0	1,567,980	0	829,266	2,397,246
2916	LUBRIC OILS-GREASES	0	2,554	0	169	2,723
2917	NAPHTHA, PETRLM SOLVENTS	0	6	0	0	6
2921	LIQUI PETR-COAL-NATR GAS	0	172,980	0	11,732	184,712
	Subzone Total :	23,727,455	13,525,691	2,547,279	1,703,151	41,503,576

Subzone 2202C

Comm. Code	Name	Dry Cargo	Tanker	Dry Cargo Barge Tow	Tanker Barge Tow	Total
1	FARM PRODUCTS	540,731	0	92,555	0	633,286
2	FOREST PRODUCTS	8	0	0	0	8
3	FISHERIES PRODUCTS	6,220	0	0	0	6,220
4	MINING PRODUCTS, NEC	18,299,287	0	1,878,536	0	20,177,823
5	PROC. FOODS & MFTRS, NEC	4,414,973	0	494,200	0	4,909,173
6	WASTE OF MANUFACTURING	177,033	0	36,402	0	213,435
1311	CRUDE PETROLEUM	0	55,418	0	3,938	59,356
1493	SULPHUR, LIQUID	0	3,146,661	0	223,622	3,370,283
2810	SODIUM HYDROXIDE (CAUSTI	66,406	0	0	0	66,406
2811	CRUDE PROD-COAL TAR-PET	36	0	1	0	37
2813	ALCOHOLS	0	8,758	0	530	9,288
2871	NITROGEN CHEM FERTILIZER	0	83,763	0	5,951	89,714
2872	POTASSIC CHEM FERTILIZER	222,761	0	45,585	0	268,346
2911	GASOLINE, INCL NATURAL	0	6,006,943	0	426,892	6,433,835
2912	JET FUEL	0	781,013	0	55,504	836,517
2913	KEROSENE	0	15,578	0	1,107	16,685
2914	DISTILLATE FUEL OIL	0	1,684,037	0	144,440	1,828,477
2915	RESIDUAL FUEL OIL	0	1,567,980	0	829,266	2,397,246
2916	LUBRIC OILS-GREASES	0	2,554	0	169	2,723
2917	NAPHTHA, PETRLM SOLVENTS	0	6	0	0	6
2921	LIQUI PETR-COAL-NATR GAS	0	172,980	0	11,732	184,712
	Subzone Total :	23,727,455	13,525,691	2,547,279	1,703,151	41,503,576

TABLE 2 Base Year 1987 Cargo Tons by Subzone, Commodity, and Vessel Type

Subzone 2203D

Comm. Code	Name	Dry Cargo	Tanker	Dry Cargo Barge Tow	Tanker Barge Tow	Total
1	FARM PRODUCTS	540,731	0	92,555	0	633,286
2	FOREST PRODUCTS	8	0	0	0	8
3	FISHERIES PRODUCTS	6,205	0	0	0	6,205
4	MINING PRODUCTS, NEC	18,299,287	0	1,878,536	0	20,177,823
5	PROC. FOODS & MFTRS, NEC	4,414,946	0	491,474	0	4,906,420
6	WASTE OF MANUFACTURING	177,033	0	36,402	0	213,435
1311	CRUDE PETROLEUM	0	55,418	0	3,938	59,356
1493	SULPHUR, LIQUID	0	3,146,661	0	223,622	3,370,283
2810	SODIUM HYDROXIDE (CAUSTI	66,406	0	0	0	66,406
2811	CRUDE PROD-COAL TAR-PET	36	0	1	0	37
2813	ALCOHOLS	0	8,758	0	530	9,288
2871	NITROGEN CHEM FERTILIZER	0	83,763	0	5,951	89,714
2872	POTASSIC CHEM FERTILIZER	222,761	0	45,585	0	268,346
2911	GASOLINE, INCL NATURAL	0	6,006,943	0	426,892	6,433,835
2912	JET FUEL	0	781,013	0	55,504	836,517
2913	KEROSENE	0	15,578	0	1,107	16,685
2914	DISTILLATE FUEL OIL	0	1,684,037	0	144,440	1,828,477
2915	RESIDUAL FUEL OIL	0	1,567,980	0	829,266	2,397,246
2916	LUBRIC OILS-GREASES	0	2,554	0	169	2,723
2917	NAPHTHA, PETRLM SOLVENTS	0	6	0	0	6
2921	LIQUI PETR-COAL-NATR GAS	0	172,980	0	11,732	184,712
	Subzone Total :	23,727,413	13,525,691	2,544,553	1,703,151	41,500,808

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Appendix V ZONE 22 Tampa, FL

TABLE 3 Base Year (1987)
Vessel Transits by Subzone, Vessel Type, and Size.

Vessel Type	Large	Medium	Small	Total
Subzone : 2201A				
Passenger	0	148	428	576
Dry Cargo	544	1,705	3,830	6,079
Tanker	286	547	133	966
Dry Cargo Barge Tow	281	0	141	422
Tanker Barge Tow	256	0	218	474
Tug/Tow Boat	0	0	182	182
Subzone Total:	1,367	2,400	4,933	8,700
Subzone : 2202C				
Passenger	0	148	1,535	1,683
Dry Cargo	544	1,705	3,830	6,079
Tanker	286	547	133	966
Dry Cargo Barge Tow	281	0	705	986
Tanker Barge Tow	256	0	1,092	1,348
Tug/Tow Boat	0	0	911	911
Subzone Total:	1,367	2,400	8,206	11,973
Subzone : 2203D				
Passenger	0	148	1,828	1,976
Dry Cargo	544	1,705	1,984	4,233
Tanker	286	547	119	952
Dry Cargo Barge Tow	281	0	683	964
Tanker Barge Tow	256	0	1,087	1,343
Tug/Tow Boat	0	0	870	870
Subzone Total:	1,367	2,400	6,570	10,337

Note: Sum of all vessel transits within each study subzone.

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Appendix V ZONE 22 Tampa, FL

TABLE 3 Base Year (1987)
Vessel Transits by Suzone, Vessel Type, Size.

ZONE TOTALS

ZONE 22 Tampa, FL

Vessel Type	Large	Medium	Small	Total
Passenger	0	148	2,935	3,083
Dry Cargo	544	1,705	3,830	6,079
Tanker	286	547	133	966
Dry Cargo Barge Tow	281	0	705	986
Tanker Barge Tow	256	0	1,092	1,348
Tug/Tow Boat	0	0	911	911
Zone Total:	1,367	2,400	9,606	13,373

Note: Sum of all arrivals/departures to/from all terminals within the Study Zone.

Appendix V ZONE 22 Tampa, FL

TABLE 4 Barges Per Tow - Average Factors by COE Waterway 8/6/91

COE Code	Waterway Name	Dry Barge	Tank Barge
	SUBZONE 2201A		
2021	TAMPA HARBOR, FLA.	2	1
2119	ST. PETERSBURG HARBOR, FLA.	2	1
	SUBZONE 2202C		
2021	TAMPA HARBOR, FLA.	2	1
2119	ST. PETERSBURG HARBOR, FLA.	2	1
	SUBZONE 2203D		
2021	TAMPA HARBOR, FLA.	2	1

NOTE: Average size of tows arriving/departing terminals within the waterway. Sizes of other tows transiting the area may differ.

Appendix V Zone 22 Tampa, FL

TABLE 5 Other Local Vessels by Subzone 7/21/91

Subzone	Name	Number of Vessels	Vessels per Square Mile
2201A		23,149	29.53
2202C		56,727	171.38
2203D		39,874	4,691.06
	Total for Zone	119,750	106.59

Note: State registered (1989/90) vessels estimated to be operated within the Subzone.

Appendix V ZONE 22 Tampa, FL

TABLE 6.1 Forecast 1995
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 2201A				
Passenger	0	159	459	617
Dry Cargo	639	2,038	4,583	7,260
Tanker	322	593	148	1,063
Dry Cargo Tow	329	0	822	1,150
Tanker Tow	288	0	1,231	1,519
Tug/Tow Boat	0	0	809	809
Subzone Total:	1,578	2,790	8,051	12,418
Subzone : 2202C				
Passenger	0	159	1,645	1,803
Dry Cargo	639	2,038	4,583	7,260
Tanker	322	593	148	1,063
Dry Cargo Tow	329	0	822	1,150
Tanker Tow	288	0	1,231	1,519
Tug/Tow Boat	0	0	809	809
Subzone Total:	1,578	2,790	9,237	13,604
Subzone : 2203D				
Passenger	0	159	1,959	2,117
Dry Cargo	639	2,038	2,388	5,065
Tanker	322	593	132	1,047
Dry Cargo Tow	329	0	796	1,124
Tanker Tow	288	0	1,225	1,513
Tug/Tow Boat	0	0	812	812
Subzone Total:	1,578	2,790	7,311	11,678

Note: Sum of all vessel transits within each study subzone.

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Appendix V ZONE 22 Tampa, FL

TABLE 6.2 Forecast 2000
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 2201A				
Passenger	0	170	491	661
Dry Cargo	711	2,282	5,099	8,092
Tanker	348	641	160	1,149
Dry Cargo Tow	364	0	905	1,269
Tanker Tow	311	0	1,321	1,632
Tug/Tow Boat	0	0	913	913
Subzone Total:	1,734	3,093	8,889	13,716
Subzone : 2202C				
Passenger	0	170	1,762	1,932
Dry Cargo	711	2,282	5,099	8,092
Tanker	348	641	160	1,149
Dry Cargo Tow	364	0	905	1,269
Tanker Tow	311	0	1,321	1,632
Tug/Tow Boat	0	0	913	913
Subzone Total:	1,734	3,093	10,160	14,987
Subzone : 2203D				
Passenger	0	170	2,099	2,268
Dry Cargo	711	2,282	2,686	5,679
Tanker	348	641	143	1,132
Dry Cargo Tow	364	0	878	1,242
Tanker Tow	311	0	1,315	1,626
Tug/Tow Boat	0	0	916	916
Subzone Total:	1,734	3,093	8,036	12,862

Note: Sum of all vessel transits within each study subzone.

Appendix V ZONE 22 Tampa, FL

TABLE 6.3 Forecast 2005
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 2201A				
Passenger	0	177	512	690
Dry Cargo	793	2,572	5,707	9,072
Tanker	375	696	172	1,243
Dry Cargo Tow	403	0	999	1,402
Tanker Tow	336	0	1,414	1,750
Tug/Tow Boat	0	0	1,036	1,036
Subzone Total:	1,907	3,445	9,839	15,192
Subzone : 2202C				
Passenger	0	177	1,837	2,015
Dry Cargo	793	2,572	5,707	9,072
Tanker	375	696	172	1,243
Dry Cargo Tow	403	0	999	1,402
Tanker Tow	336	0	1,414	1,750
Tug/Tow Boat	0	0	1,036	1,036
Subzone Total:	1,907	3,445	11,164	16,517
Subzone : 2203D				
Passenger	0	177	2,188	2,365
Dry Cargo	793	2,572	3,035	6,400
Tanker	375	696	154	1,225
Dry Cargo Tow	403	0	968	1,371
Tanker Tow	336	0	1,408	1,744
Tug/Tow Boat	0	0	1,038	1,038
Subzone Total:	1,907	3,445	8,791	14,143

Note: Sum of all vessel transits within each study subzone.

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Appendix V ZONE 22 Tampa, FL

TABLE 6.4 Forecast 2010
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 2201A				
Passenger	0	185	534	719
Dry Cargo	889	2,912	6,374	10,175
Tanker	406	756	186	1,348
Dry Cargo Tow	448	0	1,102	1,550
Tanker Tow	363	0	1,513	1,876
Tug/Tow Boat	0	0	1,182	1,182
Subzone Total:	2,106	3,853	10,891	16,850
Subzone : 2202C				
Passenger	0	185	1,916	2,101
Dry Cargo	889	2,912	6,374	10,175
Tanker	406	756	186	1,348
Dry Cargo Tow	448	0	1,102	1,550
Tanker Tow	363	0	1,513	1,876
Tug/Tow Boat	0	0	1,182	1,182
Subzone Total:	2,106	3,853	12,273	18,232
Subzone : 2203D				
Passenger	0	185	2,282	2,466
Dry Cargo	889	2,912	3,442	7,243
Tanker	406	756	167	1,329
Dry Cargo Tow	448	0	1,069	1,517
Tanker Tow	363	0	1,506	1,869
Tug/Tow Boat	0	0	1,185	1,185
Subzone Total:	2,106	3,853	9,651	15,609

Note: Sum of all vessel transits within each study subzone.

Appendix V ZONE 22 Tampa, FL

TABLE 6.5 Forecast 1995 - 2010 Vessel Transits by Vessel Type and Size

Vessel Type	Large	Medium	Small	Total
1995 FORECASTED ZONE TOTALS				
Passenger	0	159	3,145	3,303
Dry Cargo	602	1,922	4,249	6,773
Tanker	322	593	148	1,063
Dry Cargo Tow	329	0	822	1,150
Tanker Tow	288	0	1,231	1,519
Tug/Tow Boat	0	0	809	809
1995 Zone Total:	1,541	2,674	10,403	14,617
2000 FORECASTED ZONE TOTALS				
Passenger	0	170	3,369	3,539
Dry Cargo	646	2,078	4,515	7,239
Tanker	348	641	160	1,149
Dry Cargo Tow	364	0	905	1,269
Tanker Tow	311	0	1,321	1,632
Tug/Tow Boat	0	0	913	913
2000 Zone Total:	1,669	2,889	11,183	15,741
2005 FORECASTED ZONE TOTALS				
Passenger	0	177	3,513	3,691
Dry Cargo	720	2,300	4,931	7,951
Tanker	375	696	172	1,243
Dry Cargo Tow	403	0	999	1,402
Tanker Tow	336	0	1,414	1,750
Tug/Tow Boat	0	0	1,036	1,036
2005 Zone Total:	1,834	3,173	12,064	17,072
2010 FORECASTED ZONE TOTALS				
Passenger	0	185	3,663	3,848
Dry Cargo	807	2,604	5,507	8,918
Tanker	406	756	186	1,348
Dry Cargo Tow	448	0	1,102	1,550
Tanker Tow	363	0	1,513	1,876
Tug/Tow Boat	0	0	1,182	1,182
2010 Zone Total:	2,024	3,545	13,153	18,722

Note: Sum of all arrivals/departures to/from all terminals within the study zone.

TABLE 7 Vessel Casualty History (10 Year Totals) by Subzone, Vessel Type and Size, and Casualty Type

Vessel Type	Size	Collisions	Rammings	Groundings	Other	Total
Subzone: 2201A						
Dry Cargo	Large	0	0	3	0	3
Tanker	Large	0	0	1	0	1
Dry Cargo Barge Tow	Small	0	0	1	0	1
Tanker Barge Tow	Small	0	0	1	0	1
Fishing	Small	2	0	0	0	2
Subzone Totals:		2	0	6	0	8
Subzone: 2202C						
Passenger	Medium	2	0	1	0	3
Dry Cargo	Large	2	1	6	0	9
Dry Cargo	Medium	1	0	3	0	4
Tanker	Large	1	0	14	0	15
Dry Cargo Barge Tow	Large	0	0	3	0	3
Dry Cargo Barge Tow	Small	0	1	4	1	6
Tanker Barge Tow	Large	0	1	2	0	3
Tanker Barge Tow	Small	0	3	2	0	5
Tug/Tow Boat	Small	1	0	1	0	2
Fishing	Small	3	0	0	0	3
Other	Small	1	1	0	0	2
Subzone Totals:		11	7	36	1	55
Subzone: 2203D						
Passenger	Medium	0	0	1	0	1
Tanker	Large	0	0	1	0	1
Dry Cargo Barge Tow	Large	0	0	1	0	1
Tanker Barge Tow	Small	0	1	0	0	1
Subzone Totals:		0	1	3	0	4
Zone Totals:		13	8	45	1	67

Note: OTHER equals barge breakaways and weather caused vessel casualties.

APPENDIX TABLE V-8 ZONE 22, TAMPA, FL - VTS LEVELS IN OPERATION

(Not Applicable to This Sub-Zone.)

APPENDIX TABLE V-9 ZONE 22, TAMPA, FL CANDIDATE VTS DESIGN - 1995-2010

UNITS

2	Radar Module 1	- Average Performance
1	Radar Module 2	- Average Performance
0	Radar Module 3	- High Performance
0	Radar Module 4	- High Performance
0	Radar Module 5	- Special Purpose
0	Radar Module 6	- Special Purpose
0	ADS Module 7	- Active Radar Transponder (Type 1)
0	ADS Module 8	- Positional Transponder, Small Area, Very High Accuracy (Type 5)
0	ADS Module 9	- Positional Transponder, Small Area, High Accuracy (Type 6)
3	VHF Module 10	- Low power VHF Transmitting/ Receiving Facility
1	VHF Module 11	- High power VHF Transmitting/ Receiving Facility
0	Meteorological Module 12	- Air temperature, wind direction and speed
1	Meteorological Module 13	- Air temperature, wind direction and speed, visibility
1	Hydrological Module 14	- Water Temperature and Depth
0	Hydrological Module 15	- Water Temperature, Depth and Current
0	VHF/DF MODULE 16	- Line of position measurement to 2 degree RMS
0	CCTV MODULE 17	- Fixed Focus CCTV via Telephone Lines
0	CCTV MODULE 18	- Remotely Controllable CCTV via

TABLE 10A — Avoided Vessel Casualties 1996 - 2010
Candidate VTS Systems — 7/31/91

Counts

Vessel Type	Size	Collision	Ramming	Grounding	Total
Passenger	Medium	.73	0.00	1.15	1.88
Passenger	Small	.15	.03	.21	.39
Dry Cargo	Large	1.24	.24	2.19	3.67
Dry Cargo	Medium	1.58	.29	.90	2.77
Dry Cargo	Small	.95	.12	.25	1.33
Tanker	Large	1.30	.35	2.57	4.22
Tanker	Medium	.30	.03	.26	.59
Tanker	Small	.03	0.00	.03	.06
Dry Cargo Barge T	Large	3.40	0.00	4.14	7.54
Dry Cargo Barge T	Small	.73	.25	.43	1.41
Tanker Barge Tow	Large	.34	.19	.32	.85
Tanker Barge Tow	Small	1.19	.24	1.16	2.58
Tug/Tow Boat	Small	.10	.04	.11	.26
		12.05	1.79	13.71	27.55

Undiscounted Total Dollar Losses (1,000)

Vessel Type	Size	Collision	Ramming	Grounding	Total
Passenger	Medium	1,286	0	1,254	2,540
Passenger	Small	133	23	134	289
Dry Cargo	Large	1,724	451	691	2,866
Dry Cargo	Medium	2,375	576	270	3,221
Dry Cargo	Small	669	91	154	914
Tanker	Large	4,424	1,282	4,621	10,327
Tanker	Medium	567	67	144	778
Tanker	Small	269	0	29	299
Dry Cargo Barge T	Large	399	0	84	483
Dry Cargo Barge T	Small	41	39	7	87
Tanker Barge Tow	Large	2,037	1,110	1,200	4,347
Tanker Barge Tow	Small	3,396	700	582	4,678
Tug/Tow Boat	Small	8	7	9	24
		17,328	4,347	9,179	30,854

Note: In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 11 Avoided Fatalities 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Medium	.09	0.00	.14	.24
Passenger	Small	.01	.00	.01	.02
Dry Cargo	Large	.16	.03	.27	.46
Dry Cargo	Medium	.20	.04	.11	.35
Dry Cargo	Small	.06	.01	.02	.08
Tanker	Small	.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	.00	.00	.00	.00
Tanker Barge Tow	Small	.00	.00	.00	.01
Tug/Tow Boat	Small	.00	.00	.00	.00
Totals		.52	.08	.56	1.16
Candidate VTS Design - Dollars					
Passenger	Medium	138,151.69	0.00	215,770.78	353,922.48
Passenger	Small	14,343.50	2,434.88	20,349.12	37,127.50
Dry Cargo	Large	232,966.06	45,989.37	411,680.59	690,636.02
Dry Cargo	Medium	296,762.03	55,491.08	168,529.13	520,782.24
Dry Cargo	Small	91,628.36	11,968.28	23,721.59	127,318.23
Tanker	Small	99.74	0.00	114.38	214.12
Dry Cargo Barge Tow	Small	2,420.81	835.50	1,407.77	4,664.08
Tanker Barge Tow	Small	3,920.50	780.59	3,826.01	8,527.10
Tug/Tow Boat	Small	344.32	134.89	379.25	858.46
Totals		780,637.00	117,634.59	845,778.63	1,744,050.22

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 12 Avoided Human Injuries 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Medium	.01	0.00	.02	.03
Passenger	Small	.11	.02	.16	.29
Dry Cargo	Large	.02	.00	.03	.05
Dry Cargo	Medium	.02	.00	.01	.04
Dry Cargo	Small	.72	.09	.19	1.01
Tanker	Small	.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	.02	.01	.01	.03
Tanker Barge Tow	Small	.03	.01	.03	.06
Tug/Tow Boat	Small	.00	.00	.00	.01
Totals		.94	.13	.45	1.52
Candidate VTS Design - Dollars					
Passenger	Medium	2,372.03	0.00	3,704.73	6,076.76
Passenger	Small	27,009.04	4,584.92	38,317.74	69,911.70
Dry Cargo	Large	3,999.97	789.63	7,068.45	11,858.04
Dry Cargo	Medium	5,095.33	952.77	2,893.60	8,941.70
Dry Cargo	Small	172,537.72	22,536.47	44,668.15	239,742.35
Tanker	Small	174.27	0.00	199.86	374.13
Dry Cargo Barge Tow	Small	4,229.92	1,459.87	2,459.82	8,149.61
Tanker Barge Tow	Small	6,850.34	1,363.93	6,685.24	14,899.51
Tug/Tow Boat	Small	601.63	235.70	662.67	1,500.00
Totals		222,870.24	31,923.30	106,660.26	361,453.79

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 13 Avoided Vessels Damaged 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Medium	.55	0.00	.49	1.04
Passenger	Small	.13	.02	.07	.21
Dry Cargo	Large	.92	.17	.21	1.31
Dry Cargo	Medium	1.17	.21	.09	1.47
Dry Cargo	Small	.82	.09	.13	1.03
Tanker	Large	.98	.28	.34	1.60
Tanker	Medium	.23	.03	.03	.29
Tanker	Small	.01	0.00	.01	.01
Dry Cargo Barge Tow	Large	3.09	0.00	.83	3.92
Dry Cargo Barge Tow	Small	.56	.11	.06	.72
Tanker Barge Tow	Large	.31	.09	.06	.47
Tanker Barge Tow	Small	.90	.10	.16	1.17
Tug/Tow Boat	Small	.02	.00	.01	.04
Totals		9.69	1.10	2.49	13.28
Candidate VTS Design - Dollars					
Passenger	Medium	475,276.82	0.00	431,013.14	906,289.96
Passenger	Small	43,394.54	5,757.72	34,112.07	83,264.32
Dry Cargo	Large	677,129.38	127,922.50	126,776.76	931,828.64
Dry Cargo	Medium	1,042,058.17	186,473.53	38,801.82	1,267,333.52
Dry Cargo	Small	155,236.02	16,487.57	33,221.82	204,945.41
Tanker	Large	772,894.35	220,628.72	724,406.53	1,717,929.61
Tanker	Medium	149,063.23	17,252.53	61,366.03	227,681.80
Tanker	Small	1,976.58	0.00	2,956.82	4,933.40
Dry Cargo Barge Tow	Large	398,866.62	0.00	83,663.11	482,529.73
Dry Cargo Barge Tow	Small	32,444.94	6,200.44	3,012.51	41,657.88
Tanker Barge Tow	Large	50,993.48	15,270.65	12,825.50	79,089.63
Tanker Barge Tow	Small	64,194.39	7,077.35	14,545.42	85,817.17
Tug/Tow Boat	Small	1,313.76	330.58	1,407.08	3,051.42
Totals		3,864,842.28	603,401.58	1,568,108.62	6,036,352.48

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 14 Avoided Cargo Damage/Loss 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Medium	.14	0.00	.09	.23
Passenger	Small	.03	.00	.02	.05
Dry Cargo	Large	.33	.08	.20	.61
Dry Cargo	Medium	.42	.10	.08	.60
Dry Cargo	Small	.30	.04	.05	.39
Tanker	Large	.35	.10	.25	.70
Tanker	Medium	.08	.01	.03	.12
Tanker	Small	.01	0.00	.00	.01
Dry Cargo Tow	Large	.26	0.00	.30	.56
Dry Cargo Tow	Small	.10	.04	.02	.16
Tanker Tow	Large	.03	.01	.02	.06
Tanker Tow	Small	.17	.03	.07	.27
Tug/Tow Boat	Small	.01	.00	.00	.01
Totals		2.23	.42	1.14	3.79
Candidate VTS Design - Dollars					
Passenger	Medium	2,090.87	0.00	1,341.48	3,432.35
Passenger	Small	109.74	14.56	77.04	201.34
Dry Cargo	Large	3,486.22	975.04	582.57	5,043.83
Dry Cargo	Medium	4,440.90	1,176.49	238.49	5,855.87
Dry Cargo	Small	704.50	74.83	149.13	928.46
Tanker	Large	43,886.91	11,897.73	76,615.09	132,399.72
Tanker	Medium	1,796.77	201.85	878.69	2,877.31
Tanker	Small	29.62	0.00	19.92	49.54
Tanker Tow	Large	32,032.01	17,458.93	28,604.87	78,095.80
Tanker Tow	Small	13,243.26	2,639.54	5,278.93	21,161.74
Tug/Tow Boat	Small	15.81	3.98	16.49	36.28
Totals		101,836.61	34,442.93	113,802.69	250,082.23

Note 1: Dollar values include bulk petroleum and chemical cargos only and all vessel fuels spilled. Dollar values exclude cargo loss/damage for non tank vessel types.

Note 2: In Counts, 0.00 equals 0.000000; .00 represents a number less than 1 and greater than 0.000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 15 Avoided NavAid Damage 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Small	0.00	.00	.00	.00
Dry Cargo	Large	0.00	.03	.01	.04
Dry Cargo	Medium	0.00	.03	.01	.04
Dry Cargo	Small	0.00	.01	.00	.02
Tanker	Large	0.00	.04	.01	.05
Tanker	Medium	0.00	.00	.00	.01
Tanker	Small	0.00	0.00	.00	.00
Dry Cargo Barge Tow	Large	0.00	0.00	.02	.02
Dry Cargo Barge Tow	Small	0.00	.03	.00	.03
Tanker Barge Tow	Large	0.00	.02	.00	.02
Tanker Barge Tow	Small	0.00	.03	.01	.03
Tug/Tow Boat	Small	0.00	.00	.00	.01
Totals		0.00	.20	.07	.28
Candidate VTS Design - Dollars					
Passenger	Small	0.00	16.37	6.85	23.22
Dry Cargo	Large	0.00	157.82	70.73	228.55
Dry Cargo	Medium	0.00	190.43	28.95	219.38
Dry Cargo	Small	0.00	80.46	7.98	88.45
Tanker	Large	0.00	226.50	82.91	309.41
Tanker	Medium	0.00	21.04	8.42	29.45
Tanker	Small	0.00	0.00	1.12	1.12
Dry Cargo Barge Tow	Large	0.00	0.00	133.69	133.69
Dry Cargo Barge Tow	Small	0.00	163.16	13.76	176.92
Tanker Barge Tow	Large	0.00	121.01	10.39	131.39
Tanker Barge Tow	Small	0.00	152.44	37.40	189.84
Tug/Tow Boat	Small	0.00	26.34	3.71	30.05
Totals		0.00	1,155.57	405.91	1,561.48

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 16 Avoided Bridge Damage 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Small	.00	.00	0.00	.00
Dry Cargo	Large	0.00	.03	0.00	.03
Dry Cargo	Medium	0.00	.03	0.00	.03
Dry Cargo	Small	.00	.01	0.00	.01
Tanker	Large	0.00	.04	0.00	.04
Tanker	Medium	0.00	.00	0.00	.00
Tanker	Small	.00	0.00	0.00	.00
Dry Cargo Barge Tow	Small	.00	.02	0.00	.02
Tanker Barge Tow	Large	0.00	.02	0.00	.02
Tanker Barge Tow	Small	.00	.01	0.00	.02
Tug/Tow Boat	Small	.00	.00	0.00	.00
Totals		.00	.15	0.00	.16
Candidate VTS Design - Dollars					
Passenger	Small	400.33	3,053.39	0.00	3,453.72
Dry Cargo	Large	0.00	50,093.02	0.00	50,093.02
Dry Cargo	Medium	0.00	60,442.56	0.00	60,442.56
Dry Cargo	Small	2,317.55	13,593.75	0.00	15,911.30
Tanker	Large	0.00	71,890.46	0.00	71,890.46
Tanker	Medium	0.00	6,676.49	0.00	6,676.49
Tanker	Small	73.59	0.00	0.00	73.59
Dry Cargo Barge Tow	Small	1,982.04	30,744.05	0.00	32,726.10
Tanker Barge Tow	Large	0.00	38,407.04	0.00	38,407.04
Tanker Barge Tow	Small	3,210.14	28,725.33	0.00	31,935.47
Tug/Tow Boat	Small	278.39	4,903.40	0.00	5,181.79
Totals		8,262.04	308,529.50	0.00	316,791.53

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

Appendix V Zone 22 Tampa, FL
TABLE 17 Avoided Hazardous Commodity Spills 1996 - 2010 7/30/91

Commodity	Catastrophic	Large	Medium	Small	Total
Candidate Vts Design - Counts					
ALCOHOLS	.00	.00	.00	.00	.00
KEROSENE	.00	.00	.00	.00	.00
CRUDE PETROLEUM	.00	.00	.00	.00	.00
JET FUEL	.00	.01	.01	.00	.02
SULPHUR, LIQUID	.00	.04	.06	.01	.10
DISTILLATE FUEL OIL	.01	.01	.02	.29	.33
RESIDUAL FUEL OIL	.01	.07	.57	1.01	1.67
GASOLINE, INCL NATURAL	.02	.04	.07	.01	.14
	.05	.16	.73	1.32	2.26

Note: In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

Appendix V Zone 22 Tampa, FL
TABLE 18A Annual Benefit & Cost Streams 7/31/91
Candidate VTS Systems

Discounted to 1993

Year	Investment ($1,000)	Operation & Maintenance ($1,000)	Benefits ($1,000)
1993	4,784	0	0
1996	0	385	1,454
1997	0	350	1,337
1998	0	318	1,231
1999	0	290	1,135
2000	0	263	1,048
2001	0	239	967
2002	0	218	893
2003	0	198	827
2004	0	180	802
2005	0	163	702
2006	0	149	649
2007	0	135	600
2008	0	123	554
2009	0	112	512
2010	0	101	473
	4,784	3,224	13,185

Undiscounted

Year	Investment ($1,000)	Operation & Maintenance ($1,000)	Benefits ($1,000)
1993	4,784	0	0
1996	0	490	1,847
1997	0	490	1,869
1998	0	490	1,892
1999	0	490	1,920
2000	0	490	1,949
2001	0	490	1,978
2002	0	490	2,009
2003	0	490	2,047
2004	0	490	2,184
2005	0	490	2,104
2006	0	490	2,138
2007	0	490	2,174
2008	0	490	2,210
2009	0	490	2,246
2010	0	490	2,284
	4,784	7,344	30,854

APPENDIX V

ZONE 22 - TAMPA, FA

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Tampa Bay Port & Subzone	Species Category	(Port 22) Species Code	Species Name	Wildlife Abundance Tables Fish & Shellfish Grams per Square Meter Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
2201	102	128	Bighead Searobin	.0316	.0316	.0316	.0316
2201	102	128	Leopard Searobin	.0921	.0316	.0316	.0316
2201	102	130	Orange Filefish	.0158	.0316	.0316	.0316
2201	105	57	Dusky Flounder	.0658	.0658	.0987	0.0000
2201	105	57	Fringed Flounder	.1105	0.0000	.1105	0.0000
2201	105	57	Gulf Flounder	.0789	.0789	.0789	.0789
2201	105	77	Gray Triggerfish	.0884	.0884	.0884	.0884
2201	105	130	Fringed Filefish	.0316	.0316	.0526	.0316
2201	105	130	Planehead Filefish	.0316	.0316	.0658	.0316
2201	106	37	Spot	0.0000	0.0000	0.0000	.7895
2201	106	40	Bank Cusk Eel	0.0000	0.0000	.0473	0.0000
2201	106	47	Sand Seatrout	0.0000	0.0000	.1539	.0769
2201	106	48	Hardhead Catfish	0.0000	0.0000	.1065	.1065
2201	106	62	Tomtate	.0473	.0947	.0473	.0473
2201	106	62	White Grunt	.0473	.0473	.0473	.0473
2201	106	63	Pinfish	.0316	.0316	.0921	.6579
2201	106	64	Southern Kingfish	.0395	.0395	.0395	.0395
2201	106	73	Silver Jenny	.0079	.0079	.0237	.0237
2201	106	76	Bank Sea Bass	.0276	0.0000	.0461	.0461
2201	106	91	Sand Perch	.1105	.1105	.1842	.1105
2201	106	91	Silver Perch	.0395	.0395	.0395	.0395
2201	106	131	Round Scad	.0789	.0789	.0789	.0789
2201	106	134	Inshore Lizardfish	.0395	.0395	.0658	.0395
2201	106	134	Sand Diver	.0197	.0197	.0197	.0197
2201	106	239	Atlantic Bumper	.0189	.0189	.0189	.0189
2201	106	241	Pigfish	.0316	.0316	.1974	.0789
2201	108	25	Pink Shrimp	0.0000	0.0000	.0020	0.0000
2201	108	209	Blue Crab	.0040	.0040	.0020	.0040
2202	102	3	Menhaden	.0090	.0090	.0090	.0090
2202	102	33	Spanish Mackerel	.0070	0.0000	.0087	.0094
2202	102	44	Silver Mullet	12.2670	12.2670	12.2670	12.2670
2202	102	72	Spanish Sardine	.0093	.0006	.0320	.0120
2202	103	51	Crevalle Jack	.0849	.0849	.0849	.0849
2202	103	54	Dolphin	.0048	.0047	.0150	.0054
2202	104	75	Barracuda	.0005	.0006	.0027	.0009
2202	106	37	Spot	.0644	.0644	.0644	.0644
2202	106	45	Sheepshead	.0401	.0401	.0401	.0401
2202	106	46	Sea Trout	.2746	.2746	.2746	.2746
2202	106	59	Black Drum	.0737	.0737	.0737	.0737
2202	106	59	Red Drum	.0839	.0839	.0839	.0839
2202	106	62	Grunt	.0002	.0001	0.0000	0.0000
2202	106	62	Grunt	.0003	.0002	.0002	0.0000
2202	106	62	Grunt	.0029	.0074	.0036	.0010
2202	106	62	Grunt	.0045	.0005	.0002	.0041
2202	106	63	Pinfish	.0730	.0430	.0330	.0130
2202	106	68	Grouper	.0029	.0009	.0009	.0012
2202	106	70	Snapper	.0001	.0006	.0006	.0001
2202	106	70	Snapper	.0001	.0006	.0006	.0001
2202	106	70	Snapper	.0001	.0006	.0006	.0001
2202	106	70	Snapper	.0016	.0020	.0030	.0008
2202	106	73	Silver Jenny	.1350	.7000	.0470	.0670
2202	106	74	Bonefish	.0006	.0057	.0048	.0033
2202	107	212	Oyster	.0019	.0019	.0019	.0019

APPENDIX V

ZONE 22 - TAMPA, FL

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Tampa Bay		(Port 22)		Wildlife Abundance Tables Fish & Shellfish Grams per Square Meter			
Port & Subzone	Species Category	Species Code	Species Name	Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
2202	108	209	Blue Crab	.0945	.0945	.0945	.0945
2202	108	215	Shrimp	.2493	.2493	.2493	.2493
2202	108	217	Crab	.0160	.0280	.0240	.0120
2202	108	219	Spiny Lobster	.0760	.0880	.0520	.0160
2203	102	3	Menhaden	.0090	.0090	.0090	.0090
2203	102	33	Spanish Mackerel	.0070	0.0000	.0087	.0094
2203	102	44	Silver Mullet	12.2670	12.2670	12.2670	12.2670
2203	102	72	Spanish Sardine	.0093	.0006	.0320	.0120
2203	103	51	Crevalle Jack	.0849	.0849	.0849	.0849
2203	103	54	Dolphin	.0048	.0047	.0150	.0054
2203	104	75	Barracuda	.0005	.0006	.0027	.0009
2203	106	37	Spot	.0644	.0644	.0644	.0644
2203	106	45	Sheepshead	.0401	.0401	.0401	.0401
2203	106	46	Sea Trout	.2746	.2746	.2746	.2746
2203	106	59	Black Drum	.0737	.0737	.0737	.0737
2203	106	59	Red Drum	.0839	.0839	.0839	.0839
2203	106	62	Grunt	.0002	.0001	0.0000	0.0000
2203	106	62	Grunt	.0003	.0002	.0002	0.0000
2203	106	62	Grunt	.0029	.0074	.0036	.0010
2203	106	62	Grunt	.0045	.0005	.0002	.0041
2203	106	63	Pinfish	.0730	.0430	.0330	.0130
2203	106	68	Grouper	.0029	.0009	.0009	.0012
2203	106	70	Snapper	.0001	.0006	.0006	.0001
2203	106	70	Snapper	.0001	.0006	.0006	.0001
2203	106	70	Snapper	.0001	.0006	.0006	.0001
2203	106	70	Snapper	.0016	.0020	.0030	.0008
2203	106	73	Silver Jenny	.1350	.7000	.0470	.0670
2203	106	74	Bonefish	.0006	.0057	.0048	.0033
2203	107	212	Oyster	.0019	.0019	.0019	.0019
2203	108	209	Blue Crab	.0945	.0945	.0945	.0945
2203	108	215	Shrimp	.2493	.2493	.2493	.2493
2203	108	217	Crab	.0160	.0280	.0240	.0120
2203	108	219	Spiny Lobster	.0760	.0880	.0520	.0160

APPENDIX V

ZONE 22 - TAMPA, FL

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Tampa Bay Port & Subzone	Species Category	(Port 22) Species Code	Species Name	Wildlife Abundance Tables Fish & Shellfish Larvae Numbers per Square Meter Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
2201	102	1199	Larvae	.0200	.0200	0.0000	0.0000
2201	103	1199	Larvae	.2000	.2000	0.0000	0.0000
2201	104	1199	Larvae	.2000	0.0000	0.0000	0.0000
2201	105	1199	Larvae	.5000	5.0000	1.0000	1.0000
2201	106	1199	Larvae	2.2000	2.1000	0.0000	2.0000
2201	107	1199	Larvae	2.0000	20.0000	2.0000	2.0000
2201	108	1199	Larvae	.0160	.0160	.0160	.0160
2202	102	1028	Searobin	4.8230	4.8230	22.4070	22.4070
2202	102	1042	Atlantic Thread Herring	17.5500	17.5500	.1930	0.0000
2202	102	1043	Anchovy	4.2540	4.2540	2.5920	0.0000
2202	102	1044	White Mullet	.3940	.3940	3.0440	3.0440
2202	102	1121	Blenny	.0830	.0830	.5790	.5790
2202	102	1121	Longhorn Blenny	.0100	.0100	.0100	.0100
2202	102	1130	Planehead Filefish	.0160	.0160	.0160	.0160
2202	102	1238	Scaled Sardine	.1400	.1400	0.0000	0.0000
2202	103	1199	Larvae	.2000	.2000	0.0000	0.0000
2202	104	1136	Tuna	0.0000	.0330	.0330	.0330
2202	104	1199	Larvae	.2000	0.0000	0.0000	0.0000
2202	105	1199	Larvae	.5000	5.0000	1.0000	1.0000
2202	106	1034	Harvestfish	.0770	.0770	.0770	.0770
2202	106	1036	Drum	1.0000	10.0000	10.0000	0.0000
2202	106	1046	Sea Trout	.9130	.9130	.5060	.5060
2202	106	1047	Sand Sea Trout	3.2120	3.2120	3.2120	3.2120
2202	106	1058	Red drum	0.0000	1.6180	1.6180	0.0000
2202	106	1064	Kingfish	3.3260	3.3260	11.9590	11.9590
2202	106	1073	Silver Jenny	4.9990	4.9990	.0100	.0100
2202	106	1076	Bass	.0150	.0150	.0150	.0150
2202	106	1120	Gobie	0.0000	.9650	.9650	.9650
2202	106	1120	Goby	.0780	.0780	0550	.0550
2202	106	1134	Inshore Lizardfish	9.1390	9.1390	.6910	.6910
2202	106	1199	Achirus lineatus	5.9120	5.9120	1.4260	1.4260
2202	106	1199	Atlantic Spadefish	.1670	.1670	.0410	.0410
2202	106	1199	Fundulus	0.0000	0.0000	.0110	.0110
2202	106	1199	Gobia	0.0000	0.0000	.0960	.0960
2202	106	1199	Goby	.3570	.3570	10.0360	10.0360
2202	106	1199	Halfbeak	1.6890	1.6890	.0040	.0040
2202	106	1199	Other	.0070	.0070	.0450	.0450
2202	106	1199	Other	.0200	.0200	.0030	.0030
2202	106	1199	Other	.0420	.0420	.0040	.0040
2202	106	1199	Other	.1270	.1270	.1270	.1270
2202	106	1199	Other	.2420	.2420	.1210	.1210
2202	106	1199	Other	2.9440	2.9440	.5050	.5050
2202	106	1199	Star Gazer	.7150	.7150	.0340	0340
2202	106	1199	Trunkfish	.0330	.0330	1.1450	1.1450
2202	106	1239	Atlantic Bumper	3.8340	3.8340	3.0080	3.0080
2202	106	1244	Pipefish	.3090	.3090	.2110	.2110
2202	106	1257	Puffer	.0040	.0040	.0950	.0950
2202	106	1265	Needlefish	.0070	0.0000	0.0000	0.0000
2202	106	1266	White Grunt	.5370	.5370	.3510	.3510
2202	107	1199	Larvae	2.0000	20.0000	2.0000	2.0000
2202	108	1215	Pink Shrimp	0.0000	.4700	.4700	0.0000
2202	108	1218	Stone Crab	32.3000	53.6000	53.6000	0.0000
2202	160	1199	Foglossus Calli.	.3580	.3580	.3580	.3580
2203	102	1028	Searobin	4.8230	4.8230	22.4070	22.4070

APPENDIX V

ZONE 22 - TAMPA, FL

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Tampa Bay Port & Subzone	Species Category	(Port 22) Species Code	Species Name	Wildlife Abundance Tables Fish & Shellfish Larvae Numbers per Square Meter Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
2203	102	1042	Atlantic Thread Herring	17.5500	17.5500	.1930	0.0000
2203	102	1043	Anchovy	4.2540	4.2540	2.5920	0.0000
2203	102	1044	White Mullet	.3940	.3940	3.0440	3.0440
2203	102	1121	Blenny	.0830	.0830	.5790	.5790
2203	102	1121	Longhorn Blenny	.0100	.0100	.0100	.0100
2203	102	1130	Planehead Filefish	.0160	.0160	.0160	.0160
2203	102	1238	Scaled Sardine	.1400	.1400	0.0000	0.0000
2203	103	1199	Larvae	.2000	.2000	0.0000	0.0000
2203	104	1136	Tuna	0.0000	.0330	.0330	.0330
2203	104	1199	Larvae	.2000	0.0000	0.0000	0.0000
2203	105	1199	Larvae	.5000	5.0000	1.0000	1.0000
2203	106	1034	Harvestfish	.0770	.0770	.0770	.0770
2203	106	1036	Drum	1.0000	10.0000	10.0000	0.0000
2203	106	1046	Sea Trout	.9130	.9130	.5060	.5060
2203	106	1047	Sand Sea Trout	3.2120	3.2120	3.2120	3.2120
2203	106	1058	Red drum	0.0000	1.6180	1.6180	0.0000
2203	106	1064	Kingfish	3.3260	3.3260	11.9590	11.9590
2203	106	1073	Silver Jenny	4.9990	4.9990	.0100	.0100
2203	106	1076	Bass	.0150	.0150	.0150	.0150
2203	106	1120	Gobie	0.0000	.9650	.9650	.9650
2203	106	1120	Goby	.0780	.0780	.0550	.0550
2203	106	1134	Inshore Lizardfish	9.1390	9.1390	.6910	.6910
2203	106	1199	Achirus lineatus	5.9120	5.9120	1.4260	1.4260
2203	106	1199	Atlantic Spadefish	.1670	.1670	.0410	.0410
2203	106	1199	Fundulus	0.0000	0.0000	.0110	.0110
2203	106	1199	Gobia	0.0000	0.0000	.0960	.0960
2203	106	1199	Goby	.3570	.3570	10.0360	10.0360
2203	106	1199	Halfbeak	1.6890	1.6890	.0040	.0040
2203	106	1199	Other	.0070	.0070	.0450	.0450
2203	106	1199	Other	.0200	.0200	.0030	.0030
2203	106	1199	Other	.0420	.0420	.0040	.0040
2203	106	1199	Other	.1270	.1270	.1270	.1270
2203	106	1199	Other	.2420	.2420	.1210	.1210
2203	106	1199	Other	2.9440	2.9440	.5050	.5050
2203	106	1199	Star Gazer	.7150	.7150	.0340	.0340
2203	106	1199	Trunkfish	.0330	.0330	1.1450	1.1450
2203	106	1239	Atlantic Bumper	3.8340	3.8340	3.0080	3.0080
2203	106	1244	Pipefish	.3090	.3090	.2110	.2110
2203	106	1257	Puffer	.0040	.0040	.0950	.0950
2203	106	1265	Needlefish	.0070	0.0000	0.0000	0.0000
2203	106	1266	White Grunt	.5370	.5370	.3510	.3510
2203	107	1199	Larvae	2.0000	20.0000	2.0000	2.0000
2203	108	1215	Pink Shrimp	0.0000	.4700	.4700	0.0000
2203	108	1218	Stone Crab	32.3000	53.6000	53.6000	0.0000
2203	160	1199	Foglossus Calli.	.3580	.3580	.3580	.3580

APPENDIX V

ZONE 22 - TAMPA, FL

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Wildlife Abundance Tables
Birds
Numbers per Square Kilometer

Tampa Bay Port & Subzone	Species Category	(Port 22) Species Code	Species Name	Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
2201	112	511	Duck	300.0000	0.0000	300.0000	600.0000
2201	112	512	Coot	80.0000	0.0000	80.0000	160.0000
2201	112	513	Goose	160.0000	0.0000	160.0000	320.0000
2201	112	570	Shore Birds	57.3000	65.0000	112.0000	225.0000
2201	113	530	Seabirds	2.3000	2.3000	2.3000	2.3000
2202	111	511	Other Waterfowl	0.0000	0.0000	1.2388	2.4776
2202	111	515	Lesser Scaup	0.0000	0.0000	32.0310	64.0620
2202	111	516	Common Loon	0.0000	0.0000	.2425	.4851
2202	111	517	Horned Grebe	0.0000	0.0000	.4851	.9701
2202	112	561	Black Crowned Night Heron	.0970	.0970	.0970	.0970
2202	112	561	Cattle Egret	5.8207	5.8207	5.8207	5.8207
2202	112	561	Great Blue Heron	.5821	.5821	.5821	.5821
2202	112	561	Great Egret	1.0671	1.0671	1.0671	1.0671
2202	112	561	Little Blue Heron	.5821	.5821	.5821	.5821
2202	112	561	Reddish Egret	.0582	.0582	.0582	.0582
2202	112	561	Snowy Egret	1.9402	1.9402	1.9402	1.9402
2202	112	561	Tricolored Heron	1.9402	1.9402	1.9402	1.9402
2202	112	561	Yellow Crowned Night Heron	.6791	.6791	.6791	.6791
2202	112	564	Glossy Ibis	.5820	.5820	.5820	.5820
2202	112	564	White Ibis	19.7905	19.7905	19.7905	19.7905
2202	112	571	Snowy Plover	.0970	.0970	.0970	.0970
2202	112	572	American Oystercatcher	.1164	.1164	.1164	.1164
2202	112	572	Black Necked Stilt	.0582	.0582	.0582	.0582
2202	113	530	Anninga	.1940	.1940	.1940	.1940
2202	113	530	Double Crested Cormorant	1.4552	1.4552	1.4552	1.4552
2202	113	531	Laughing Gull	56.7908	56.7908	56.7908	56.7908
2202	113	533	Caspian Tern	.0873	.0873	.0873	.0873
2202	113	533	Gull Billed Tern	.0194	.0194	.0194	.0194
2202	113	533	Royal Tern	1.9402	1.9402	1.9402	1.9402
2202	113	544	Magnificent Frigate Bird	1.2612	1.2612	0.0000	0.0000
2202	113	546	American White Pelican	.1940	.1940	.1940	.3880
2202	113	546	Brown Pelican	5.8207	5.8207	5.8207	5.8207
2202	113	548	Black Skimmer	1.5522	1.5522	1.5522	1.5522
2202	114	581	Osprey	.0485	.0485	.0485	.0485
2202	114	582	Bald Eagle	.0329	.0329	.0329	.0329
2203	111	511	Other Waterfowl	0.0000	0.0000	1.2388	2.4776
2203	111	515	Lesser Scaup	0.0000	0.0000	32.0310	64.0620
2203	111	516	Common Loon	0.0000	0.0000	.2425	.4851
2203	111	516	Common Loon	0.0000	0.0000	.2425	.4851
2203	111	517	Horned Grebe	0.0000	0.0000	.4851	.9701
2203	112	561	Black Crowned Night Heron	.0970	.0970	.0970	.0970
2203	112	561	Cattle Egret	5.8207	5.8207	5.8207	5.8207
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2203	112	561	Tricolored Heron	1.9402	1.9402	1.9402	1.9402
2203	112	561	Yellow Crowned Night Heron	.6791	.6791	.6791	.6791
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2203	113	530	Anninga	.1940	.1940	.1940	.1940

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Tampa Bay Port & Subzone	Species Category	(Port 22) Species Code	Species Name	Wildlife Abundance Tables Birds Numbers per Square Kilometer Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
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2203	113	533	Royal Tern	1.9402	1.9402	1.9402	1.9402
2203	113	544	Magnificent Frigate Bird	1.2612	1.2612	0.0000	0.0000
2203	113	546	American White Pelican	.1940	.1940	.1940	.3880
2203	113	546	Brown Pelican	5.8207	5.8207	5.8207	5.8207
2203	113	548	Black Skimmer	1.5522	1.5522	1.5522	1.5522
2203	114	581	Osprey	.0485	.0485	.0485	.0485
2203	114	582	Bald Eagle	.0329	.0329	.0329	.0329

APPENDIX W

MOBILE, AL

(ZONE 23)

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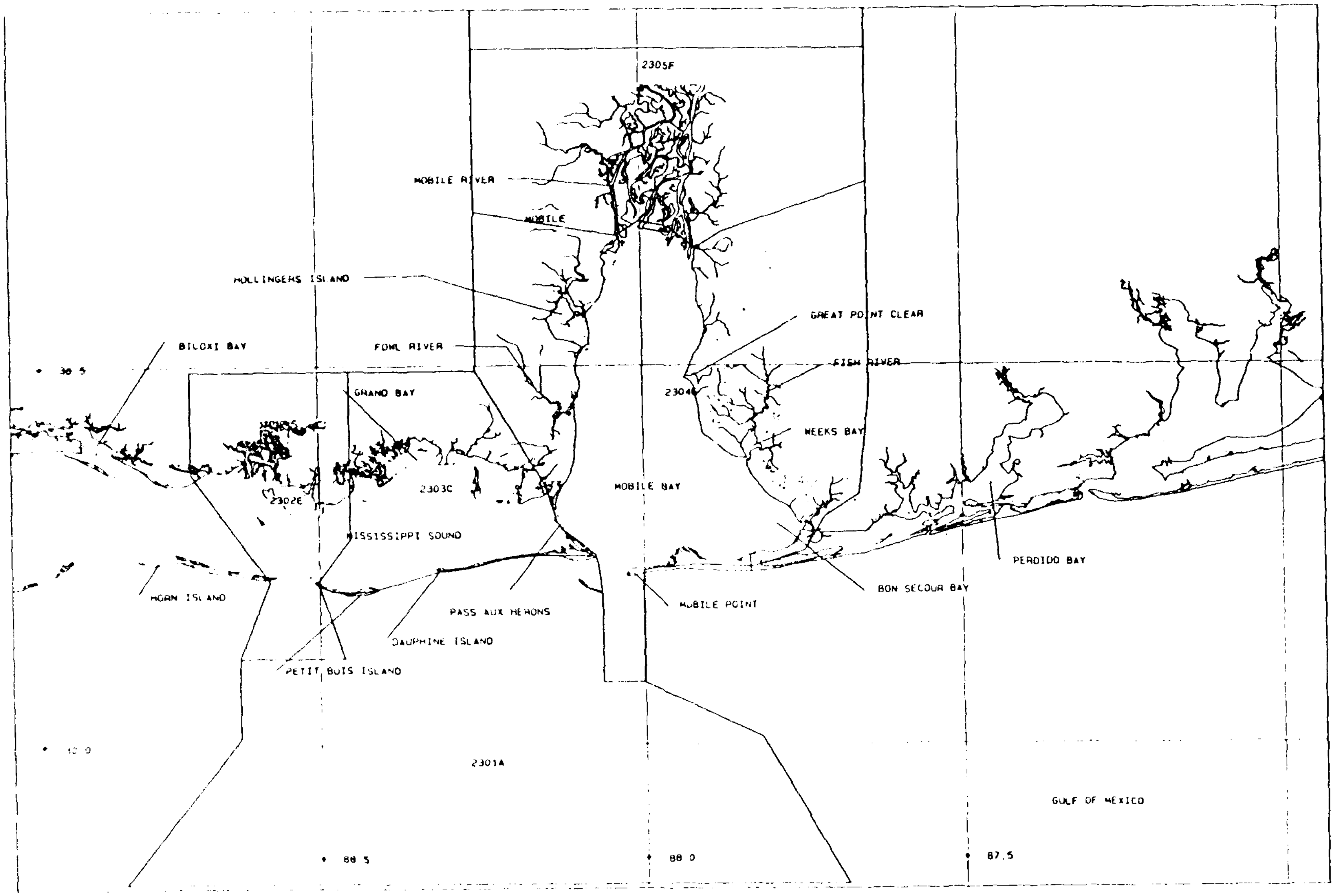
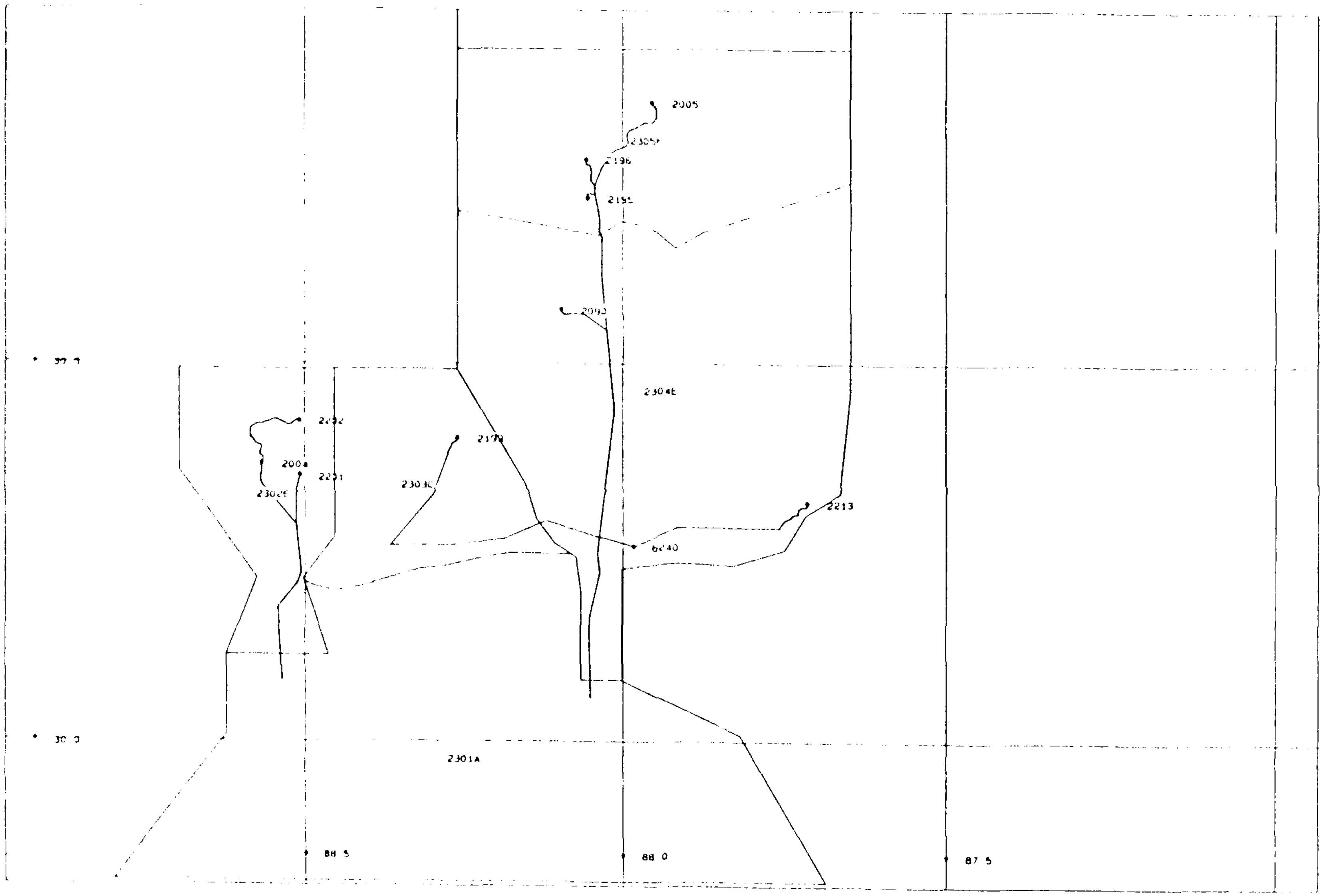
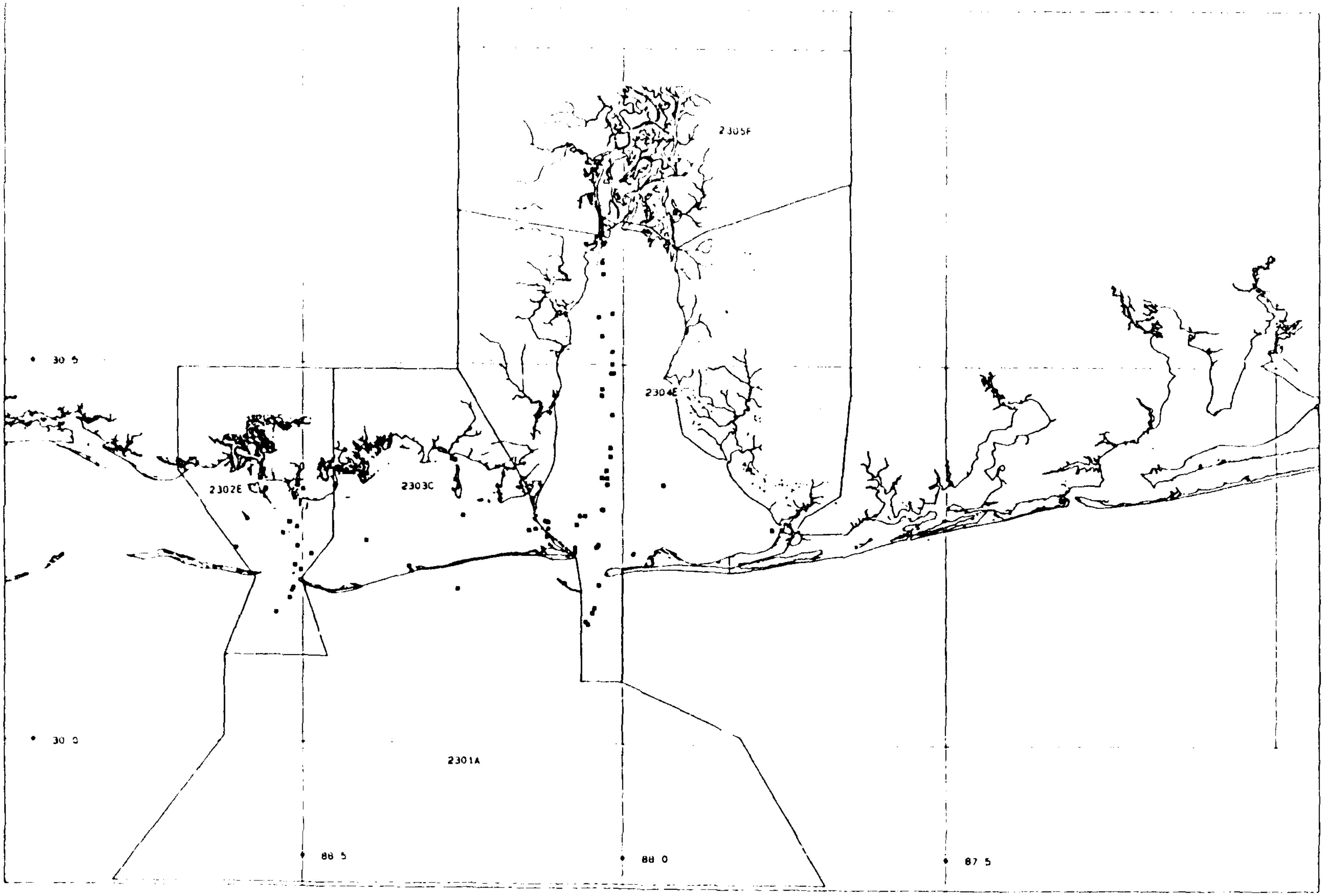
STUDY ZONE MAPS



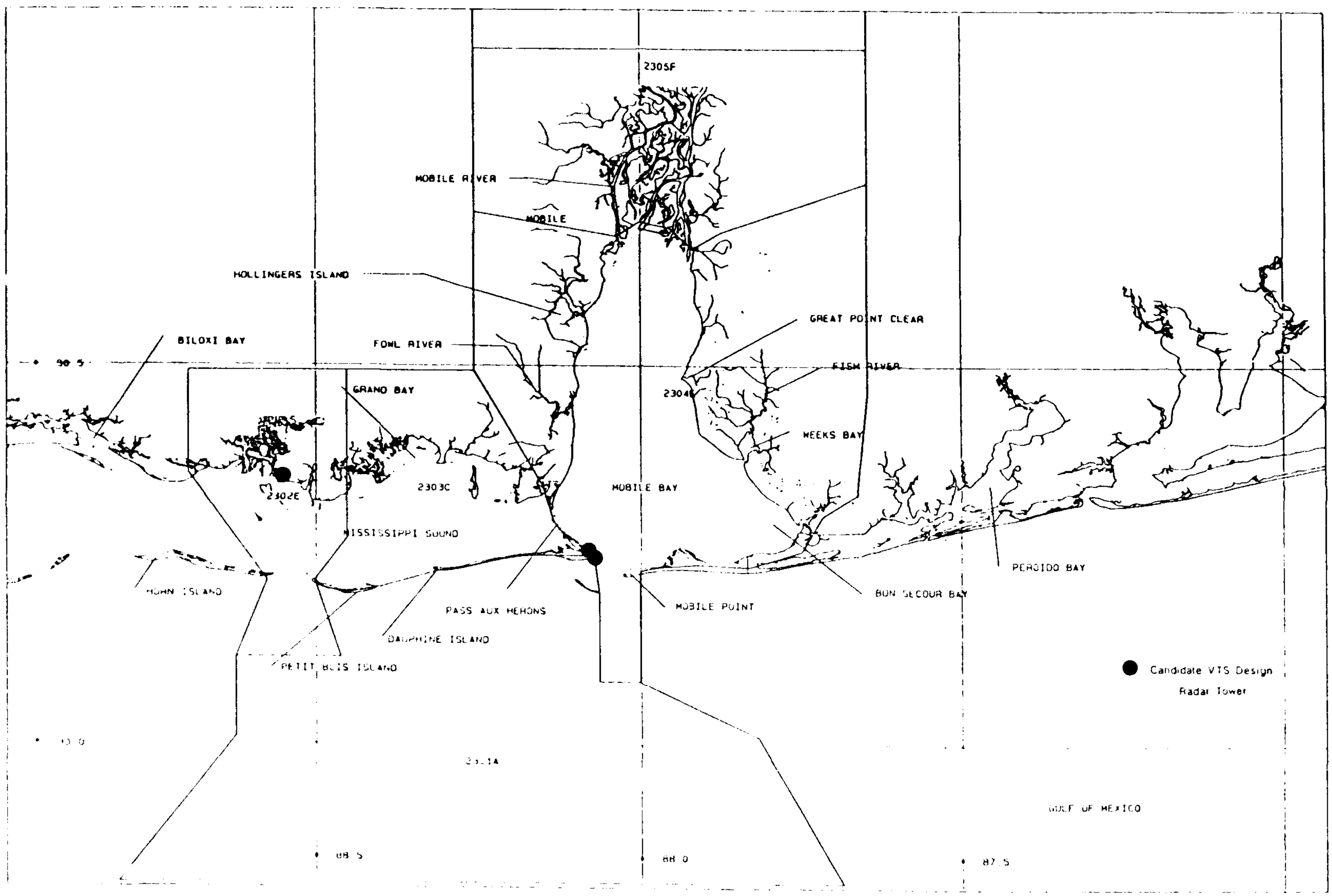
ZONE 23 - MOBILE, AL - ZONE AND SUBZONE BOUNDARIES



ZONE 23 - MOBILE, AL - DOMINANT VESSEL ROUTES AND COE WATERWAY CODES



ZONE 23 - MOBILE, AL - BASE PERIOD (10 YEAR) VESSEL CASUALTIES



ZONE 23 - MOBILE, AL - CANDIDATE VTS DESIGN RADAR LOCATIONS

CANDIDATE VTS DESIGN REPORT

FOR

MOBILE, AL

(ZONE 23)

Prepared for:
U.S. Department of Transportation
Research and Special Programs Administration
John A. Volpe National Transportation Systems Center
Cambridge, MA 02142

Prepared by:
NAVCOM Systems, Inc.,
7203 Gateway Court
Manassas, VA 22110

July 1991

OVERVIEW

The Candidate VTS Design described in this appendix is one of 23 developed for all the study zones included in the study. This appendix documents the task performed, under Contract DTRS-57-88-C-00088 Technical Task Directive 13, as an integral part of the total Port Needs Study. The ultimate product of this task effort is an informed preliminary technical assessment of the approximate cost to the Federal Government to implement and operate a state-of-the-art VTS system. This appendix does not contain a comprehensive definition of the VTS operating requirements nor does it propose a final VTS specification suitable for implementation.

In order to consistently estimate the life cycle costs of a VTS system in each of the study zones, a "Candidate VTS Design" has been defined for each study zone using a uniform set of design criteria. Each study zone Candidate VTS Design is a composite of generic modules selected from a master list of 18 state-of-the-art surveillance modules, communications and display technology. Among the surveillance modules in the master list are several levels of technical performance from which the selection is made for application to each study sub-zone to address the local navigational surveillance needs and conditions. The Candidate VTS Design in each study zone represents a consistent application of the surveillance modules at the sub-zone level. The sub-zone surveillance technology is subsequently integrated into a total system for the study zone via state-of-the-art communications and display consoles at the Vessel Traffic Center (VTC) in each zone.

The application of the surveillance modules in each sub-zone responds to the technical requirements of that sub-zone as perceived by the study team. The Candidate VTS Design represents a preliminary engineering judgement on the appropriate level of technology in each sub-zone. The Candidate VTS Design may be considered as an informed judgement made by the contractor study team for the sole purpose of developing cost estimates that are consistent across the 23 study zones and suitable for benefit/cost comparisons among the study zones and initial budget planning and implementation priorities. The approach used to calculate VTS system costs for all 23 study zones is found in Volume III, Technical Supplement.

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MOBILE, ALABAMA VTS DESIGN

1.0 SCOPE

This report includes a port survey and a VTS design for the Port of Mobile. The port survey is based on a review of all pertinent literature including navigational charts. The methodology used to produce the VTS design entails coupling the problems identified in the port survey with solutions offered by state-of-the-art technology as identified in the VTS Technology Survey, November 1990. When possible, technological advances which permit manpower reductions are applied. Not all VTS problems are amenable to strictly technological solutions; some require changes in procedures and/or enforcement. These situations are identified where they occur.

2.0 PORT OF MOBILE SURVEY

2.1 INTRODUCTION

This survey report is based exclusively upon review of available literature and examination of the charts for the area and its approaches. The information thus gained has been evaluated and interpreted based upon the Survey Team's experience as professional mariners and in vessel traffic management systems.

The Survey Area includes the Port of Mobile, the facilities located on Mobile Bay accessible to deep-draft shipping, and the seaward approaches to Mobile Bay.

Mobile is 28 miles inland from the entrance to Mobile Bay and is reached by a narrow man-made and maintained deep-draft channel. Although the Bay gives the appearance of open water, its utility outside of the main channel is generally limited to craft drawing 9' or less. Although deep-draft traffic must be considered moderate, in 1987 the ports of Mobile Bay ranked 10th in the United States in terms of barge movements. The major traffic management considerations are those imposed by the long, narrow channels which serve the port, and the need to prevent critical meetings within those channels.

The area is environmentally sensitive, with large expanses of sensitive wetlands.

2.2 OVERVIEW OF THE PORT

Climate within the Survey Area is classified as Sub-tropical Coastal, with warm, humid summers and mild winters. Two characteristics are important to vessel traffic management, the relatively frequent occurrence of strong frontal action and the occurrence of fog. About twenty significant frontal systems move

through Mobile each year, usually accompanied by strong winds and heavy rain. The winds can be strong enough to affect the handling of lightly laden of high-sided ships. Inshore, visibility drops to less than two miles about 5% of the time between December and April, with the worse conditions occurring in December and January (Reference 1).

The diurnal tidal range is quite small, averaging 1.2' at Mobile Point and 1.5' at Mobile itself. Strong winds can modify the tidal range significantly, with winter "northers" depressing Mobile Bay by over a foot. Winds also have marked effect upon the predicted times of occurring high and low tides, and upon tidal current velocities. Normal tidal current velocities are less than 0.5 knot but can be increased to over ten knots by prolonged winds.

Entrance to Mobile Bay from the Gulf of Mexico is through a series of Safety Fairways. The Mobile Bay Fairway Anchorage, south of the junction of the Safety Fairways leading to the port, is the only deep-draft anchorage for the port, although there is an Explosives Anchorage hard by Mobile Point. The entrance channel provides 42 feet over the bar, for a width of 600', but is naturally wider in spots. The entrance is well-marked and is well-covered by Loran-C. It can, however, be difficult in conditions of poor visibility because of the proximity of shoal water, particularly along the reach between Mobile Bay Entrance Channel Lighted Buoys 8 and 10.

A Federal project provides 40' to Magazine Point at the head of the Mobile Ship Channel, with lesser depths in various branch channels. The tabulations on Chart 11376 should be consulted for exact depths and widths. In general, channels throughout are too narrow to permit the meeting of wide-beam ships. Inside the Bay, channels are well marked by buoyage, fixed aids and ranges. The bottom is soft mud and sand. There are reports that the pilots consider the limiting draft to be 42.5' which, if true, reflect the slushy nature of the bottom.

Pilotage is compulsory for all foreign-flag ships and U. S.-flag ships under register in the foreign trade, and optional for U. S.-flag ships in the coastwise trade with who have on board a pilot licensed by the Federal Government. Pilot service is provided by the Mobile Bar Pilots Association, who maintain a pilot station at Fort Gaines. The station monitors Channel 16 VHF-FM. The pilots, Harbormaster and berthing tugs guard Channel 65A, which is used as an Intraharbor Circuit. Pilot Boats also guard Channel 13.

Forty eight hours advance notice of arrival is required by the pilots, who board inbound ships in the vicinity of Mobile Entrance Lighted Horn Buoy M. Pilots leave departing ships in the same general area.

The Mobile Bay area has numerous waterfront facilities, cataloged by Report No. 18, U. S. Army Corps of Engineers Port Series Reports. Principal exports are marine supplies, paper products, forestry products, aluminum, flour, chemicals, grain, coal and bunkers, iron and steel products and fertilizer. Imports include bauxite, chemicals, seafood, newsprint, rubber and ores. Coastwise trade consists mainly of petroleum products, lumber, iron and steel, frozen foods and chemicals. The inland trade is primarily iron and steel products, coal, ore and grain.

2.3 EXISTING TRAFFIC MANAGEMENT

2.3.1 General Practice

General practice is to limit maximum draft to 42.5' and to prevent the meeting of ships whose beams are 115' or greater (Reference 1).

2.3.2 Explosives Anchorage

An Explosives Anchorage is established by 33CFR194 1000 yards north of Mobile Point. No vessel may occupy the anchorage without permission of the U. S. Coast Guard Captain of the Port (COTP), and the area may be used as a general anchorage when explosives-carrying ships are not present.

2.3.3. Inland Waters Navigation Regulations

33CFR Part 162 publishes regulations for all waterways tributary to the Gulf of Mexico. The rules are general in nature consisting, among other things, of a general prohibition about anchoring in channels, rules for mooring to banks and the like.

2.3.4. Harbor Regulations

The Alabama State Docks Department exercises state jurisdiction over Mobile Bay. It has supervision over state pilots and shipping, as well as authority in all matters relating to the arrival, departures, loading and discharging of all vessels at <u>state wharves</u>. Routine functions are exercised through the Harbormaster. A speed limit of six knots exists above Mobile Channel Light 76.

2.4 VESSEL TRAFFIC

In 1987 Mobile handled 32.4 million tons of cargo, of which 3.3 million consisted of petroleum products (gasoline, jet fuel and fuel oil). Tank ships numbered 217 and 4618 barge movements were recorded (Reference 3). An average of 948 deep-draft ship transits occur each year, counting vessels of all types.

Good information about overall barge traffic is unavailable, particularly for ICW traffic simply passing through Mobile Bay and not calling at a facility there.

2.5 ENVIRONMENTAL SENSITIVITY

The shorelines of Dauphin Island and the Fort Morgan Peninsula comprise a sensitive area providing a critical habitat for aquatic birds and spawning fish. Much of Mobile Bay and its shoreline is also of importance to aquatic life, recreation and the quality of life for coastal residents. A detailed environmental study has been prepared by the National Oceanic and Atmospheric Administration (NOAA) and published by NOAA's Ocean Assessment Division as "Oil and Hazardous Substances Planning and Response Considerations for Mobile Bay."

"Worse Case" is considered to be a major oil or hazardous materials spill at or near the ICW junctions, under conditions which would block channels and permit the pollutant to spread both within and without the Bay.

2.6 PORT SUB-ZONES

The Study Area was examined to determine appropriate sub-zones, using the methodology based upon the "confined-complex", "open-complex", "confined-simple" and "open-simple" system employed by the Canadian VTS Study in 1984 (Reference 4). Briefly stated, "open" and "confined" address the influence of geography upon a ship's ability to maneuver; and "simple" vs "complex" is descriptive of the nature of the interactions between ships within those geographic areas. This basic matrix was overlaid by a subjective assessment of appropriate traffic management/risk amelioration measures in order to derive sub-zones within which VTS needs are homogeneous, or nearly so.

2.6.1 Sub-Zone I -- Offshore Approaches (NOAA Chart 11006 & 11376)

The sub-zone lies seaward of a line originating at the shoreline and drawn due south to a point at 30^0-00'N 88^0-15'W, thence east to 30^0-00'N 87^0-50'W and from that point north to the shoreline.

The sub-zone provides opportunity for inbound ships to establish communications with the pilots and Vessel Traffic Center well in advance of arrival at the sea buoy. This permits the adjustment of arrival times, if required, to facilitate safe entry. The use of this sub-zone to establish communications and commence queuing, when required, permits the Mobile Bay channels to be managed as "one-way" if desired.

The sub-zone is drawn so that the fairway anchorage and the intersections of the Safety Fairways may be included in Sub-Zone II.

The sub-zone is "open-simple."

2.6.2 Sub-Zone II -- Mobile Bay Entrance (NOAA Charts 11006 & 11376)

The sub-zone lies inshore of the boundaries of Sub-Zone I (a line originating at the shoreline and drawn due south to a point at 30^0-00'N 88^0-15'W, thence east to 30^0-00'N 87^0-50'W and from that point north to the shoreline) and a line across the entrance of Mobile Bay between Fort Gaines and Mobile Point.

The sub-zone contains the pilot boarding area, the fairway anchorage and the intersection of five safety fairways. These contribute to the potential for congestion and the random interaction of vessels. Under conditions of low visibility the VTC should be capable of providing navigational assistance as well as movement management advice.

The sub-zone is "confined-complex."

2.6.3 Sub-Zone III -- Upper Mobile Bay (NOAA Chart 11376)

The sub-zone consists of all of Mobile Bay inshore of Sub-Zone II (a line across the entrance of Mobile Bay between Fort Gaines and Mobile Point) and south of an east-west line drawn through Mobile Channel Light 76. Those portions of the Intracoastal Waterway (ICW) west of the Dauphin Island Bridge and east of 87^0-55'W are excluded.

Outside of the Project channels the sub-zone consists of shoal water. Some tugs with barges, recreational and fishing craft can operate outside of the Project channel, but those vessels normally draw nine feet or less. Some of the Project channels are only 300' in width and there are substantial reaches where widths are 500". Although cross-track position-fixing assistance is impractical in such narrow channels, the along-track element is critical to movement management; particularly in preventing meetings at channel junctions, narrow channels and areas where ships are maneuvering to make or clear berths.

The sub-zone is "confined-complex."

2.6.4 Sub-Zone IV -- Mobile (NOAA Chart 11376)

This sub-zone extends from the northern limits of Sub-Zone III (an east-west line drawn through Mobile Channel Light 76) and the Head of Deep-Water Navigation in the Port of Mobile. The Tensaw River east and north of Choctaw Pass is excluded.

The sub-zone is "confined-complex."

2.6.5 Sub-Zone V -- Tensaw River (NOAA Chart 11376)

This sub-zone consists of the Tensaw River east and north of Choctaw Pass to approximately 32^0-52'N.

This sub-zone forms a data catchment area for traffic downbound on the Tensaw River for the main channel, permitting the VTC to obtain data about the vessel(s) in advance of their entry into Sub-Zone IV.

The sub-zone is "confined-simple."

2.7 PROBLEMM AREA IDENTIFIERS

2.7.1 PAI II-1. Fairway Anchorage (NOAA Chart 11006)

The Fairway Anchorage represents a major traffic management resource which may require surveillance and careful management under certain conditions.

2.7.2 PAI II-2. Fairway Junction (NOAA Chart 11376)

Five Safety Fairways join southeast of Mobile Entrance Lighted Horn Buoy M. This junction also contains the Pilot Boarding Area and is at the entrance of a channel which requires careful navigation to transit. The vicinity also offers the opportunities for interaction between dissimilar types of vessels, not all of which may be VTS participants.

The VTC must be capable of providing movement management advice and navigational assistance, as required.

2.7.3 PAI III-1. Mobile Bay Entrance (NOAA Chart 11376)

The area immediately inside Sub-Zone III contains an explosives anchorage, a ferry crossing and the intersection of the main channel with the ICW. In addition it is a focal point for fishing, recreational and small commercial craft. The capability to manage the explosives anchorage and provide management advice is required.

2.7.4 PAI III-2. Upper ICW Junction (NOAA Chart 11376)

There are two branches of the ICW which join the main channel 6.8 miles north of the entrance. The configuration was designed to serve ICW traffic calling at Mobile. The VTC must have real-time information about traffic in this area and be able to provide movement management advice.

2.7.5 PAI III-3. Great Point Clear Junction (NOAA Chart 11376)

A number of shoal- and deep-draft channels join the main channel in an area to the west of Great Point Clear, with the potential for adverse interactions that such junctions represent. Among the channels of concern are the Theodore Ship Channel and the Hollingers Island Channel. The VTC must have real-time information about traffic in this area and be able to provide movement management advice.

2.7.6 PAI IV-1. Pinto Island Reach (NOAA Chart 11376)

The Pinto Island Reach and its southern approaches represent an area where the potential for congestion is high. This includes the junctions with the main channel of Arlington Channel and the Tensaw River. The VTC must have real-time information about traffic in this area and be able to provide movement management advice.

2.7.7 PAI IV-2. Mobile (NOAA Chart 11376)

Careful queuing is required to manage traffic through the channels within metropolitan Mobile. The area is also the point of origin for a substantial portion of the outbound traffic queue the management of which is essential to traffic safety lower down the Bay. A ferry dedicated to the carriage of vehicles with hazardous materials on board operates across the main channel near St. Louis Point. The VTC must have real-time information about traffic in this area and be able to provide movement management advice.

3.0 MOBILE VTS DESIGN

3.1 INTRODUCTION

A detailed survey of the Port of Mobile is the basis for this design. An approach to costing VTS systems is outlined in Vol. III, Technical Supplement and a method of categorizing surveillance sensors into "modules" has also been developed. These modules are defined in terms of cost and performance and are to be applied to all VTS designs in this study. The applicability of Automatic Dependent Surveillance (ADS)

technology is also discussed in this report. The five sub-zones defined in the harbor survey remain the same.

Traffic management requirements for each sub-zone are developed from PAI analysis. Table 3-1 lists in tabular form a summation of the problems identified and the management required by sub-zone.

The hardware and software selected for this design provide the level of surveillance justified by the problems identified in each sub-zone. A secondary consideration is to locate all VTS assets so that they are sufficient for the sub-zone in question and can contribute to adjoining sub-zones to achieve maximum usage. All specific equipments are then selected based on perceived surveillance requirements and overall VTS system architecture.

3.1.1 VTS Design Approach

The choice of surveillance sensors is dependent on the VTS mission. For the purposes of this design, the VTS mission is defined as that which insures the safety of navigation and the protection of the environment. In order to accomplish this mission, mandatory participation of all vessels over 20 meters is essential. The Vessel Traffic Center (VTC) must provide navigation safety advice to all vessels. The VTS in the United States will have no facilitation of commerce role nor will it offer piloting assistance of any kind.

The primary criteria for selection of adequate surveillance sensors are:

- o Percentage of vessels of the desired minimum size detected in designated surveillance areas
- o Percentage of lost tracks
- o Accuracy of the position and track obtained
- o Reliability of the surveillance system
- o Timeliness of the data obtained
- o Ability to interpret and use the data obtained

Secondary criteria are:

- o Cost of the VTS system -- reduction of manpower by the use of technology
- o Expandability -- increased VTS responsibility, area, and/or support of other missions

TABLE 3-1. MOBILE, AL PROBLEM AREA IDENTIFIERS

PAI	LOCATION	PROBLEM	MANAGEMENT
I	Offshore Approaches	Data catchment area for inbound shipping. Commence inbound queuing.	Have knowledge of ship movement, intentions and characteristics. Enter inbound traffic into database. Manage inbound queue.
II	Mobile Bay entrance	Pilot boarding area, potential congestion. Inbound queue must be regulated with modifications based on weather, tides. Navigation assistance may be required.	Real-time information of ship positions and movements. Provide navigational assistance and advice as required. Manage anchorage.
III	Upper Mobile Bay	Narrow channels where meetings, overtakings must be managed. Potential for localized congestion. Queuing control and anchorage management required.	Real-time information of ship positions and movements. Provide movement management advice, manage anchorage.
IV	Mobile	Potential congestion. Outbound queuing begins here. Conditions vary with weather, tides. Cross channel ferry carries hazardous cargo.	Have real-time knowledge of vessel movements. Be able to provide movement management advice as required.
V	Tensaw River	Data catchment area for downbound traffic.	Knowledge of vessel movements, characteristics and intentions.

Active surveillance sensors including radar, communications, and closed circuit television (CCTV) installations are used when detection and tracking of vessels is paramount to providing safety advice. These devices are considered fail safe in that it is known with certainty when they have failed. The performance characteristics of these sensors are known from operational VTS worldwide experience. In this design they are selected to assure that the necessary operational criteria identified for each sub-zone is realized.

Many dependent surveillance techniques are possible. These range from voice radio reporting of required VTS data to automatic position and identification recording devices that can be interrogated from shore known as Automatic Dependent Surveillance (ADS) devices. The position and/or movement reporting form of dependent surveillance is used extensively in existing VTS systems. The major regions of current use are those which do not require active surveillance. To apply ADS technology to a specific sub-zone within a VTS zone the following additional criteria must be considered:

- o The number and class of vessels interacting in the sub-zone and which of these interactions are important to the VTS mission. Obviously all vessel classes of interest must be appropriately equipped. This requires that all vessels of the classes selected which will ever pass through this sub-zone must be equipped with an ADS device. This requirement to detect so many different vessels argues against the use of ADS. In areas where only one class of vessel is of interest, ADS is more easily implemented.

- o The interactions or transits to be monitored must not demand that the surveillance be fail safe, i.e. positively detecting failures. This type of surveillance is related to position reporting in that it may not always function or be used properly and the VTS has limited control over its operation.

- o It must be determined that if active surveillance is not justified, the additional information obtained from ADS over position reporting is necessary.

- o If the class or group of vessels to be monitored is a "controllable" group, ADS can be easily implemented and satisfactory operation more readily achieved. Controllable means a clearly defined subset of vessels, e.g. a specific barge company; vessels carrying a specific cargo, etc.

- The number of different vessels in each class of interest that passes through the sub-zone in question must be determined. This number must be known to accurately estimate the cost of selecting this option for this sub-zone.

- A specific ADS solution for one sub-zone in one harbor may affect all the VTS designs for all the other sub-zones in all the other harbors.

3.1.2 Assumptions

The design of this VTS system starts with a set of assumptions based on the detailed survey and other data. These assumptions are as follows:

- As recommended by the IMO, all vessels of 20 meters or more in length are required to participate in the VTS. Participation is defined (at a minimum) as monitoring the VTS frequency and reporting as required.

- The VTS system is implemented with the cooperation and assistance of the port authorities, pilots associations, and marine exchange, if any. The existing facilities, services, and procedures established and operated by these organizations are major elements of an integrated VTS system as defined in the IMO VTS Guidelines.

- The life-cycle of all system hardware is ten years.

3.2 DESIGN DECISIONS (FIGURE 3-1)

3.2.1 General

Examination of the traffic levels, geographical features and identified problem areas in the port leads to the following selection and location of sensor hardware.

3.2.2 Hardware Location and Selection

3.2.2.1 Sub-Zone III

<u>Ft. Gaines Site</u>	1 Module 3 radar 1 Module 4 radar 1 Module 10 VHF 1 Module 11 VHF
<u>Deer River Point Site</u>	1 Module 10 VHF

Surveillance Modules -Sub Zones	RADAR						ADS			VHF		MET.		HYD.		DF	CCTV		COMMENTS
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
I																			Comms and partial Radar coverage from Sub-Zone III
II																			Comms/Radar coverage from Sub-Zone III
III			1	1						2	1								
IV										1	1				1				
V																			

FIGURE 3-1. MOBILE, AL SURVEILLANCE SURVEY

3.2.2.2 Sub-Zone IV

Little Sand Island Site	1 Module 10 VHF
	1 Module 11 VHF
	1 Module 15 HYD

3.2.3 Vessel Traffic Center

The design of the hardware and software should be modern and capable of operating with reduced staff levels and no loss of effectiveness. One watchstander with an integrated data workstation and decision aiding software can effectively manage the activity in this port. This Vessel Traffic Center concept demands that the watchstander be separated from any other harbor/port information requests. The Center must be structured so that such requests are controlled by a bulletin board type interface. One officer-in-charge and one clerk are also required for the proper administration of the facility.

The Vessel Traffic Center is located in Mobile in a location with good visual surveillance of the Mobile ship channel. The center is to employ the following equipment:

3.2.3.1 VTS Console

This console provides total data integration from all sensors in all sectors. These data are graphically shown on raster scan, high light level, color displays. A data display is also provided. Console design architecture is general purpose computer based, open architecture, bus organized, allowing operation of the system as a local area network (LAN). Data interchange with other facilities by modem is provided as well as interface with the U.S. Coast Guard standard terminal. The design allows board level modification and expansion. Features of the software and hardware provided are:

- o Software written in a high level language.
- o Software providing the total integration of data from all VTS sensors.
- o Layering of data in at least four layers to be operator selectable.
- o The ability to sector data including sector to sector handoff of targets.
- o The ability to accept external digital data derived from transmissions of shipboard transponders or other sources and integrate the information with all other sensor data.

- o Automatic and/or manual acquisition of radar targets including automatic tracking and target ID assignments. Guard zones with automatic acquisition of all targets entering the zone.

- o Several warning levels of vessel interaction designed to direct attention to developing situations rather than a simple CPA alarm strategy.

- o Complete vessel monitoring and alarm capability including anchor watch, CPA, TCPA, track history, adjustable target velocity vectors, restricted area penetration and maneuvering monitor is provided. Additional warning and/or alarm features allowed by programming changes in high level language.

- o Complete modern color graphics capability with offset and zoom

- o Complete harbor navigation aid monitoring capability including buoy position, light status, etc.

- o Remote control of all radars and radar interfaces as well as radar data processing including site-to-site integration, clutter suppression, scan conversion and target extraction.

- o Complete track projection capability which can predict and/or analyze future interactions based on current position, destination and velocity.

- o The capability of constructing a complete vessel data base and interfacing it to the real-time data display from the VTS sensors.

3.2.3.2 Communications Console

This console is capable of remotely operating the proposed transmitting/receiving sites and allowing transmission and monitoring on all required frequencies. The console provides two operating positions each to be capable of complete communications control. It is capable of modular expansion if other remote communications sites are added.

3.2.3.3 Supervisor Control and Data Acquisition (SCADA) Equipment

A SCADA capability is provided to the major module level at remote sites so that the watchstander can determine the status of the entire VTS system. A graphic readout is provided in block diagram form indicating operational status of all elements in the system. Security monitoring of remote sites is also included.

3.2.3.4 Recording Equipment

Time synchronized video and audio recording equipment is to be provided. This equipment is capable of recording and playing back the data presented to the VTS watchstander and his reaction to the situation. An extra set of recording equipment is to be installed for redundancy purposes.

3.3 COST ESTIMATES

3.3.1 General

Vol. III, Technical Supplement discusses a generalized approach to estimating VTS system costs. This approach is based on interviews with system designers and purchasers of recently constructed systems. The cost of this VTS system has been estimated using this approach and is detailed below. The assumptions made in estimating these costs are listed in Paragraph 3.1.2.

3.3.2 Hardware (x $1000)

Vessel Traffic Center	non-recurring	recurring(10-yr)
VTS Console (1 workstation & all software)	500	
Communications console	100	
Recording Equipment	50	
SCADA Equipment (1 radar site)	200	
Sub-total:	850	400

Sub-Zone I--Offshore Approaches (NOAA Chart 11006 & 11376)

Comms and partial radar coverage from Sub-Zone III.

Sub-Zone II--Mobile Bay Entrance (NOAA Charts 11006 & 11376)

Comms/radar coverage from Sub-Zone III.

Sub-Zone III--Upper Mobile Bay (NOAA Chart 11376)

1 Module 3 radar	400	400
1 Module 4 radar	400	400
2 Module 10 VHF	38	26
1 Module 11 VHF	48	20
Sub-total:	886	846

Sub-Zone IV--Mobile (NOAA Chart 11376)

1 Module 10 VHF	19	13
1 Module 11 VHF	48	20
1 Module 15 HYD	50	5
Sub-total:	117	38
HARDWARE TOTALS:	1853	1284

3.3.3 Project Totals (x $1000)

Non-recurring

Hardware	$1853
Management, Engineering, etc. (50%) Assumptions: Turnkey system, Procurement by integ.contractor, good manufacturer support, some software provided, System Manual required	927
Installation site integration (20%) Assumptions: Complete installation by contractor, remote access no serious problem, many widespread sites	371
Spares & Training (10%)	185
Civil Engineering 1 remote radar site, a VTC in Mobile, remote comms and WX sensors installations, land acquisition	1000
PROJECT ESTIMATE:	4336
Data Base Management System	300
TOTAL: (non-recurring)	$ 4636

Recurring (10 year)

Hardware	1284
1 Watchstander x 5 = 5 man/years @ 50K x 10	2500
1 Officer-in-Charge	500
1 Clerk	500
TOTAL: (recurring) (10-year life)	$ 4784
TOTAL 10-YEAR PROJECT COST:	$ 9420

REFERENCES

1. United States Coast Pilot, Volume 5. Atlantic Coast: Gulf of Mexico, Puerto Rico, and the Virgin Islands, 21st Edition, NOAA, Washington, D.C., 1989.

2. Ibid, p. 2.

3. Summary Statistics on Leading U.S. Ports, Center for Marine Conservation, Washington, D.C. 1990.

4. Final Report, National Vessel Traffic Services Study (TP5965E), Canadian Coast Guard, Ottawa, 1984, pp. 89-91.

GLOSSARY

ADS: Automatic Dependent Surveillance

ARPA: Automatic Radar Plotting Aid.

"CONFINED-COMPLEX": a combination of terms relating to the geography and the nature of the interactions between ships. See Final Report National Vessel Traffic Services Study (TP-5965E), Canadian Coast Guard, Ottawa, October 1984, pp.89-91.

"CONFINED-SIMPLE": a combination terms relating to the geography and the nature of the interactions between ships. See Final Report National Vessel Traffic Services Study (TP-5965E), Canadian Coast Guard, Ottawa, October 1984, pp.89-91.

COTP: Captain of the Port

CCTV: closed circuit television

COLREGS LINE: a demarcation line delineating those waters upon which international regulations for the prevention of collisions at sea apply.

CPA: closest point of approach

DBMS: data base management system

DF: direction finder

FAA: Federal Aviation Administration

GIS: Geographic Information System

ICW: Intracoastal Waterway

IMO: International Maritime Organization

KW: Kilowatt

LAN: local area network

LLOYD'S LIST: a listing of all merchant vessels of the world including their physical characteristics. Published by Lloyd's of London.

LNG: liquified natural gas

NOAA: National Oceanic and Atmospheric Administration

"OPEN-COMPLEX": a combination of terms relating to the geography and the nature of the interactions between ships. See Final Report National Vessel Traffic Services Study (TP-5965E), Canadian Coast Guard, Ottawa, October 1984, pp. 89-91.

"OPEN-SIMPLE": a combination of terms relating to the geography and the nature of the interactions between ships. See Final Report National Vessel Traffic Services Study (TP-5965E), Canadian Coast Guard, Ottawa, October 1984, pp. 89-91.

PAI: Problem Area Identifier

PRECAUTIONARY AREA: an area normally an intersection, entrance to, or exit from a traffic separation scheme where vessel interactions are unpredictable

SCADA: Supervisor Control and Data Acquisition

TCPA: time of closest point of approach

TRAFFIC SEPARATION SCHEME: routes incorporating traffic separation to increase the safety of navigation, particularly in converging areas of high traffic density.

VHF: very high frequency

VTC: vessel traffic center

VTS: vessel traffic services

APPENDIX

ADDITIONAL COST REQUIRED FOR ADDING

SURVEILLANCE EQUIPMENT

MOBILE, ALABAMA (Including Pascagoula, Mississippi)

1.0 HARDWARE COSTS (x $1000)

Vessel Traffic Center	non-recurring	recurring(10-yr)
VTS Console (2 workstations & all software)	750	
Communications console	100	
Recording Equipment	50	
SCADA Equipment (1 radar site)	200	
Sub-total:	1100	500

Sub-Zone I--Offshore Approaches (NOAA Chart 11006 & 11376)

Comms and partial radar coverage from Sub-Zone III.

Sub-Zone II--Mobile Bay Entrance (NOAA Charts 11006 & 11376)

Comms/radar coverage from Sub-Zone III.

Pascagoula Site		
1 Module 1 radar	310	310
1 Module 10 VHF	19	13
Sub-total:	329	323

Sub-Zone III--Upper Mobile Bay (NOAA Chart 11376)		
1 Module 3 radar	400	400
1 Module 4 radar	400	400
2 Module 10 VHF	38	26
1 Module 11 VHF	48	20
Sub-total:	886	846

Sub-Zone IV--Mobile (NOAA Chart 11376)		
1 Module 10 VHF	19	13
1 Module 11 VHF	48	20
1 Module 15 HYD	50	5
Sub-total:	117	38
HARDWARE TOTALS:	2432	1707

Mobile, Alabama (Continued)

2.0 PROJECT TOTALS (x $1000)

2.1 NON-RECURRING

Hardware	$2432
Management, Engineering, etc. (50%) Assumptions: Turnkey system, Procurement by integ.contractor, good manufacturer support, some software provided, System Manual required	1216
Installation site integration (20%) Assumptions: Complete installation by contractor, remote access no serious problem, many widespread sites	486
Spares & Training (10%)	243
Civil Engineering 2 remote radar sites, a VTC in Mobile, remote comms and WX sensors installations, land acquisition	1500
PROJECT ESTIMATE:	5877
Data Base Management System	300
TOTAL: (non-recurring)	$ 6177

2.2 Recurring (10 year)

Hardware	1707
1 Watchstander x 5 = 5 man/years @ 50K x 10	2500
1 Officer-in-Charge	500
1 Clerk	500
TOTAL: (recurring) (10-year life)	$ 5207
TOTAL 10-YEAR PROJECT COST:	$11384

COMMENTS

1. Includes new radar site at Pascagoula, Mississippi.

Surveillance Modules -Sub Zones	RADAR						ADS			VHF		MET.		HYD.		DF	CCTV		COMMENTS
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
I																			Comms and partial Radar coverage from Sub-Zone III
II	1									1									Comms/Radar coverage from Sub-Zone III
III			1	1						2	1								
IV										1	1				1				

MOBILE, AL SURVEILLANCE SURVEY

STUDY ZONE INPUT DATA AND OUTPUT STATISTICS

TABLE 1 Assignment of COE Waterway Codes to Subzones 8/06/91

COE Waterway		Name
Subzone 2301A		
2004	A	PASCAGOULA HARBOR, MISS.
2005	A	MOBILE HARBOR, ALA.
2090	A	DOG AND FOWL RIVERS, ALA.
2195	A	THREE MILE CREEK, ALA.
2196	A	CHICKASAW CREEK, ALA.
2199	A	BAYOU LA BATRE, ALA.
2201	A	BAYOU CASOTTE, MISS.
2202	A	PASCAGOULA RIVER, MISS.
2213	A	BON SECOUR RIVER, ALA.
6240	A	GULF INTRACOASTAL WATERWAY, PENSACOLA BAY, FLA., TO
Subzone 2302E		
2004	A	PASCAGOULA HARBOR, MISS.
2004	B	PASCAGOULA HARBOR, MISS.
2201	A	BAYOU CASOTTE, MISS.
2201	B	BAYOU CASOTTE, MISS.
2202	A	PASCAGOULA RIVER, MISS.
2202	B	PASCAGOULA RIVER, MISS.
Subzone 2303C		
2199	A	BAYOU LA BATRE, ALA.
2199	B	BAYOU LA BATRE, ALA.
Subzone 2304E		
2005	A	MOBILE HARBOR, ALA.
2005	B	MOBILE HARBOR, ALA.
2090	A	DOG AND FOWL RIVERS, ALA.
2090	B	DOG AND FOWL RIVERS, ALA.
2195	A	THREE MILE CREEK, ALA.
2195	B	THREE MILE CREEK, ALA.
2196	A	CHICKASAW CREEK, ALA.
2196	B	CHICKASAW CREEK, ALA.
2199	A	BAYOU LA BATRE, ALA.
2199	B	BAYOU LA BATRE, ALA.
2213	A	BON SECOUR RIVER, ALA.
2213	B	BON SECOUR RIVER, ALA.
6240	A	GULF INTRACOASTAL WATERWAY, PENSACOLA BAY, FLA., TO
6240	B	GULF INTRACOASTAL WATERWAY, PENSACOLA BAY, FLA., TO
Subzone 2305F		
2005	A	MOBILE HARBOR, ALA.
2005	B	MOBILE HARBOR, ALA.
2195	A	THREE MILE CREEK, ALA.
2195	B	THREE MILE CREEK, ALA.
2196	A	CHICKASAW CREEK, ALA.
2196	B	CHICKASAW CREEK, ALA.

TABLE 2 Base Year 1987 Cargo Tons by Subzone, Commodity, and Vessel Type

Subzone 2301A

Comm. Code	Name	Dry Cargo	Tanker	Dry Cargo Barge Tow	Tanker Barge Tow	Total
1	FARM PRODUCTS	3,376,017	0	583,069	0	3,959,086
2	FOREST PRODUCTS	201,054	0	0	0	201,054
3	FISHERIES PRODUCTS	1,357	0	0	0	1,357
4	MINING PRODUCTS, NEC	9,182,769	0	13,481,897	0	22,664,666
5	PROC. FOODS & MFTRS, NEC	8,105,764	0	13,036,578	0	21,142,342
6	WASTE OF MANUFACTURING	40,443	0	212,027	0	252,470
1311	CRUDE PETROLEUM	0	43,556,335	0	6,527,353	50,083,688
1493	SULPHUR, LIQUID	0	528,580	0	421,948	950,528
2810	SODIUM HYDROXIDE (CAUSTI	42,772	0	370,869	0	413,641
2811	CRUDE PROD-COAL TAR-PET	57	0	22,609	0	22,666
2813	ALCOHOLS	0	1,329	0	59,878	61,207
2817	BENZENE AND TOLUENE	0	0	0	400,007	400,007
2818	SULPHURIC ACID	0	0	0	488,554	488,554
2871	NITROGEN CHEM FERTILIZER	165	787	0	176,725	177,677
2872	POTASSIC CHEM FERTILIZER	80,588	0	111,581	0	192,169
2873	PHOSPHA CHEM FERTILIZERS	4	0	2,837	0	2,841
2911	GASOLINE, INCL NATURAL	0	7,296,247	0	7,784,995	15,081,242
2912	JET FUEL	0	2,621,853	0	1,459,718	4,081,571
2913	KEROSENE	0	45,816	0	38,316	84,132
2914	DISTILLATE FUEL OIL	0	4,494,355	0	3,369,318	7,863,673
2915	RESIDUAL FUEL OIL	0	1,257,196	0	2,697,243	3,954,439
2916	LUBRIC OILS-GREASES	0	26,096	0	151,946	178,042
2917	NAPHTHA, PETRLM SOLVENTS	0	1,427	0	790,145	791,572
2921	LIQUI PETR-COAL-NATR GAS	2,047	394,451	0	811,743	1,208,241
	Subzone Total :	21,033,037	60,224,472	27,821,467	25,177,889	134,256,865

Subzone 2302E

Comm. Code	Name	Dry Cargo	Tanker	Dry Cargo Barge Tow	Tanker Barge Tow	Total
1	FARM PRODUCTS	1,410,662	0	229,849	0	1,640,511
2	FOREST PRODUCTS	193,604	0	0	0	193,604
3	FISHERIES PRODUCTS	965	[illegible]	0	0	965
4	MINING PRODUCTS, NEC	128,010	0	155,537	0	283,547
5	PROC. FOODS & MFTRS, NEC	4,616,001	0	4,028,191	0	8,644,192
6	WASTE OF MANUFACTURING	1,[illegible]2	0	34,665	0	36,407
1311	CRUDE PETROLEUM	0	42,718,806	0	0	42,718,806
1493	SULPHUR, LIQUID	0	528,580	0	252,788	781,368
2810	SODIUM HYDROXIDE (CAUST'	0	0	62,210	0	62,210
2811	CRUDE PROD-COAL TAR-PET	[illegible]	0	8,204	0	8,204
2817	BENZENE AND TOLUENE	0	0	0	394,455	394,455
2818	SULPHURIC ACID	0	0	0	488,554	488,554
2871	NITROGEN CHEM FERTILIZER	0	0	0	72,106	72,106
2872	POTASSIC CHEM FERTILIZER	0	0	106,158	0	106,158
2873	PHOSPHA CHEM FERTILIZERS	0	0	2,762	0	2,762
2911	GASOLINE, INCL NATURAL	0	6,985,509	0	4,403,235	11,388,744
2912	JET FUEL	0	2,413,614	0	965,643	3,379,257
2914	DISTILLATE FUEL OIL	0	3,756,884	0	2,171,424	5,928,308
2915	RESIDUAL FUEL OIL	0	735,068	0	948,248	1,683,316
2916	LUBRIC OILS-GREASES	0	24,419	0	52,396	76,815
2917	NAPHTHA, PETRLM SOLVENTS	0	0	0	225,030	225,030
2921	LIQUI PETR-COAL-NATR GAS	2,047	387,483	0	737,656	1,127,186
	Subzone Total :	6,353,031	57,550,363	4,627,576	10,711,535	79,242,505

TABLE 2 Base Year 1987 Cargo Tons by Subzone, Commodity, and Vessel Type

Subzone 2303C

Comm. Code	Name	Dry Cargo	Tanker	Dry Cargo Barge Tow	Tanker Barge Tow	Total
5	PROC. FOODS & MFTRS, NEC	10	0	7,673	0	7,683
	Subzone Total :	10	0	7,673	0	7,683

Subzone 2304E

Comm. Code	Name	Dry Cargo	Tanker	Dry Cargo Barge Tow	Tanker Barge Tow	Total
1	FARM PRODUCTS	1,965,355	0	353,220	0	2,318,575
2	FOREST PRODUCTS	7,450	0	0	0	7,450
3	FISHERIES PRODUCTS	392	0	0	0	392
4	MINING PRODUCTS, NEC	9,054,759	0	13,326,360	0	22,381,119
5	PROC. FOODS & MFTRS, NEC	3,489,763	0	9,008,387	0	12,498,150
6	WASTE OF MANUFACTURING	38,701	0	177,362	0	216,063
1311	CRUDE PETROLEUM	0	837,529	0	6,527,353	7,364,882
1493	SULPHUR, LIQUID	0	0	0	169,160	169,160
2810	SODIUM HYDROXIDE (CAUSTI	42,772	0	308,659	0	351,431
2811	CRUDE PROD-COAL TAR-PET	57	0	14,405	0	14,462
2813	ALCOHOLS	0	1,329	0	59,878	61,207
2817	BENZENE AND TOLUENE	0	0	0	5,552	5,552
2871	NITROGEN CHEM FERTILIZER	165	787	0	104,619	105,571
2872	POTASSIC CHEM FERTILIZER	80,588	0	5,423	0	86,011
2873	PHOSPHA CHEM FERTILIZERS	4	0	75	0	79
2911	GASOLINE, INCL NATURAL	0	310,738	0	3,381,760	3,692,498
2912	JET FUEL	0	208,239	0	494,075	702,314
2913	KEROSENE	0	45,816	0	38,316	84,132
2914	DISTILLATE FUEL OIL	0	737,471	0	1,197,894	1,935,365
2915	RESIDUAL FUEL OIL	0	522,128	0	1,748,995	2,271,123
2916	LUBRIC OILS-GREASES	0	1,677	0	99,550	101,227
2917	NAPHTHA, PETRLM SOLVENTS	0	1,427	0	565,115	566,542
2921	LIQUI PETR-COAL-NATR GAS	0	6,968	0	74,087	81,055
	Subzone Total :	14,680,006	2,674,109	23,193,891	14,466,354	55,014,360

Subzone 2305F

Comm. Code	Name	Dry Cargo	Tanker	Dry Cargo Barge Tow	Tanker Barge Tow	Total
1	FARM PRODUCTS	1,965,355	0	205,543	0	2,170,898
2	FOREST PRODUCTS	7,450	0	0	0	7,450
3	FISHERIES PRODUCTS	392	0	0	0	392
4	MINING PRODUCTS, NEC	9,049,400	0	7,022,232	0	16,071,632
5	PROC. FOODS & MFTRS, NEC	3,400,206	0	8,211,010	0	11,611,216
6	WASTE OF MANUFACTURING	20,179	0	91,390	0	111,569
1311	CRUDE PETROLEUM	0	837,529	0	6,527,353	7,364,882
2810	SODIUM HYDROXIDE (CAUSTI	1,506	0	308,659	0	310,165
2811	CRUDE PROD-COAL TAR-PET	57	0	12,623	0	12,680
2813	ALCOHOLS	0	43	0	28,921	28,964
2817	BENZENE AND TOLUENE	0	0	0	496	496
2871	NITROGEN CHEM FERTILIZER	165	787	0	39,408	40,360
2872	POTASSIC CHEM FERTILIZER	80,588	0	2,102	0	82,690
2873	PHOSPHA CHEM FERTILIZERS	4	0	0	0	4
2911	GASOLINE, INCL NATURAL	0	24,900	0	2,264,634	2,289,534
2912	JET FUEL	0	208,239	0	188,643	396,882
2913	KEROSENE	0	45,816	0	38,316	84,132
2914	DISTILLATE FUEL OIL	0	385,993	0	779,786	1,165,779
2915	RESIDUAL FUEL OIL	0	471,843	0	1,499,149	1,970,992
2916	LUBRIC OILS-GREASES	0	1,677	0	28,913	30,590
2917	NAPHTHA, PETRLM SOLVENTS	0	676	0	534,921	535,597
	Subzone Total :	14,525,302	1,977,503	15,853,559	11,930,540	44,286,904

Appendix W ZONE 23 Mobile, AL

TABLE 3 Base Year (1987)
Vessel Transits by Subzone, Vessel Type, and Size.

Vessel Type	Large	Medium	Small	Total
Subzone : 2301A				
Passenger	0	0	5,440	5,440
Dry Cargo	429	1,248	6,300	7,977
Tanker	844	1,011	131	1,986
Dry Cargo Barge Tow	7	0	0	7
Tanker Barge Tow	86	0	0	86
Tug/Tow Boat	86	0	0	86
Subzone Total:	1,452	2,259	11,871	15,582
Subzone : 2302E				
Dry Cargo	128	252	1,986	2,366
Tanker	811	859	86	1,756
Dry Cargo Barge Tow	3	0	521	523
Tanker Barge Tow	79	0	2,650	2,729
Tug/Tow Boat	18	0	2,665	2,683
Subzone Total:	1,039	1,111	7,908	10,058
Subzone : 2303C				
Passenger	0	0	40	40
Dry Cargo	0	0	1,746	1,746
Dry Cargo Barge Tow	0	0	20	20
Tanker Barge Tow	0	0	1	1
Tug/Tow Boat	0	0	53	53
Subzone Total:	0	0	1,860	1,860
Subzone : 2304E				
Passenger	0	0	5,400	5,400
Dry Cargo	301	996	4,314	5,611
Tanker	33	152	45	230
Dry Cargo Barge Tow	4	0	6,173	6,177
Tanker Barge Tow	6	0	2,265	2,271
Tug/Tow Boat	68	0	4,760	4,828
Subzone Total:	413	1,148	22,957	24,518

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Appendix W ZONE 23 Mobile, AL

TABLE 3 Base Year (1987)
Vessel Transits by Subzone, Vessel Type, and Size.

Vessel Type	Large	Medium	Small	Total
Subzone : 2305F				
Dry Cargo	301	996	425	1,722
Tanker	33	152	42	227
Dry Cargo Barge Tow	4	0	4,008	4,012
Tanker Barge Tow	6	0	1,302	1,309
Subzone Total:	344	1,148	5,777	7,269

ZONE TOTALS

ZONE 23 Mobile, AL

Vessel Type	Large	Medium	Small	Total
Passenger	0	0	5,440	5,440
Dry Cargo	429	1,248	6,300	7,977
Tanker	844	1,011	131	1,986
Dry Cargo Barge Tow	7	0	6,694	6,701
Tanker Barge Tow	86	0	4,915	5,000
Tug/Tow Boat	86	0	7,425	7,511
Zone Total:	1,452	2,259	30,905	34,615

Note: Sum of all arrivals/departures to/from all terminals within the Study Zone.

TABLE 4 Barges Per Tow - Average Factors by COE Waterway 8/6/91

COE Code	Waterway Name	Dry Barge	Tank Barge
	SUBZONE 2301A		
2004	PASCAGOULA HARBOR, MISS.	3	3
2005	MOBILE HARBOR, ALA.	5	5
2090	DOG AND FOWL RIVERS, ALA.	5	5
2195	THREE MILE CREEK, ALA.(INCLUDED IN TRAFFIC OF MOBILE HARBOR, ALA.)	5	5
2196	CHICKASAW CREEK, ALA.(INCLUDED IN TRAFFIC OF MOBILE HARBOR, ALA.)	5	5
2199	BAYOU LA BATRE, ALA.	5	5
2201	BAYOU CASOTTE, MISS.(INCLUDED IN TRAFFIC OF PASCAGOULA HARBOR, MISS.)	3	3
2202	PASCAGOULA RIVER, MISS.	3	3
2213	BON SECOUR RIVER, ALA.	5	5
6240	GULF INTRACOASTAL WATERWAY, PENSACOLA BAY, FLA., TO MOBILE BAY, ALA. (INCLUDED IN GULF INTRACOASTAL WATERWAY CONSOLIDATED REPORT)	3	3
	SUBZONE 2302E		
2004	PASCAGOULA HARBOR, MISS.	3	3
2201	BAYOU CASOTTE, MISS.(INCLUDED IN TRAFFIC OF PASCAGOULA HARBOR, MISS.)	3	3
2202	PASCAGOULA RIVER, MISS.	3	3
	SUBZONE 2303C		
2199	BAYOU LA BATRE, ALA.	5	5
	SUBZONE 2304E		
2005	MOBILE HARBOR, ALA.	5	5
2090	DOG AND FOWL RIVERS, ALA.	5	5
2195	THREE MILE CREEK, ALA.(INCLUDED IN TRAFFIC OF MOBILE HARBOR, ALA.)	5	5
2196	CHICKASAW CREEK, ALA.(INCLUDED IN TRAFFIC OF MOBILE HARBOR, ALA.)	5	5
2199	BAYOU LA BATRE, ALA.	5	5
2213	BON SECOUR RIVER, ALA.	5	5
6240	GULF INTRACOASTAL WATERWAY, PENSACOLA BAY, FLA., TO MOBILE BAY, ALA. (INCLUDED IN GULF INTRACOASTAL WATERWAY CONSOLIDATED REPORT)	3	3
	SUBZONE 2305F		
2005	MOBILE HARBOR, ALA.	5	5
2195	THREE MILE CREEK, ALA.(INCLUDED IN TRAFFIC OF MOBILE HARBOR, ALA.)	5	5
2196	CHICKASAW CREEK, ALA.(INCLUDED IN TRAFFIC OF MOBILE HARBOR, ALA.)	5	5

NOTE: Average size of tows arriving/departing terminals within the waterway. Sizes of other tows transiting the area may differ.

Appendix W Zone 23 Mobile, AL

TABLE 5 Other Local Vessels by Subzone 7/21/91

Subzone	Name	Number of Vessels	Vessels per Square Mile
2301A		4,385	3.50
2302E		4,385	30.88
2303C		4,385	23.20
2304E		9,775	22.37
2305F		9,775	814.58
	Total for Zone	32,705	16.08

Note: State registered (1989/90) vessels estimated to be operated within the Subzone.

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Appendix W ZONE 23 Mobile, AL

TABLE 6.1 Forecast 1995
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 2301A				
Passenger	0	0	6,000	6,000
Dry Cargo	542	1,549	7,481	9,572
Tanker	1,165	982	62	2,209
Dry Cargo Tow	2	0	6,506	6,508
Tanker Tow	88	0	5,065	5,153
Tug/Tow Boat	0	0	6,093	6,093
Subzone Total:	1,797	2,531	31,207	35,534
Subzone : 2302E				
Dry Cargo	162	311	2,561	3,034
Tanker	1,124	819	10	1,953
Dry Cargo Tow	0	0	596	596
Tanker Tow	84	0	3,007	3,091
Tug/Tow Boat	0	0	3,122	3,122
Subzone Total:	1,370	1,130	9,296	11,796
Subzone : 2303C				
Passenger	0	0	316	316
Dry Cargo	0	0	2,036	2,036
Dry Cargo Tow	0	0	23	23
Tanker Tow	0	0	1	1
Tug/Tow Boat	0	0	15	15
Subzone Total:	0	0	2,390	2,390
Subzone : 2304E				
Passenger	0	0	6,004	6,004
Dry Cargo	380	1,271	4,948	6,599
Tanker	41	173	52	266
Dry Cargo Tow	2	0	7,191	7,193
Tanker Tow	4	0	2,450	2,454
Tug/Tow Boat	0	0	4,446	4,446
Subzone Total:	427	1,444	25,091	26,962

Appendix W ZONE 23 Mobile, AL

TABLE 6.1 Forecast 1995
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 2305F				
Passenger	0	0	246	246
Dry Cargo	380	1,271	542	2,193
Tanker	41	173	49	263
Dry Cargo Tow	2	0	4,671	4,672
Tanker Tow	4	0	1,357	1,362
Tug/Tow Boat	0	0	4,427	4,427
Subzone Total:	427	1,444	11,292	13,163

Appendix W ZONE 23 Mobile, AL

TABLE 6.2 Forecast 2000
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 2301A				
Passenger	0	0	6,315	6,315
Dry Cargo	632	1,796	8,334	10,762
Tanker	1,425	1,066	71	2,562
Dry Cargo Tow	2	0	7,154	7,156
Tanker Tow	95	0	5,431	5,527
Tug/Tow Boat	0	0	6,844	6,844
Subzone Total:	2,154	2,862	34,150	39,166
Subzone : 2302E				
Dry Cargo	190	353	2,993	3,536
Tanker	1,378	882	11	2,271
Dry Cargo Tow	0	0	648	648
Tanker Tow	91	0	3,255	3,345
Tug/Tow Boat	0	0	3,620	3,620
Subzone Total:	1,659	1,235	10,527	13,421
Subzone : 2303C				
Passenger	0	0	332	332
Dry Cargo	0	0	2,223	2,223
Dry Cargo Tow	0	0	24	24
Tanker Tow	0	0	1	1
Tug/Tow Boat	0	0	15	15
Subzone Total:	0	0	2,595	2,595
Subzone : 2304E				
Passenger	0	0	6,320	6,320
Dry Cargo	442	1,483	5,375	7,300
Tanker	47	195	60	302
Dry Cargo Tow	2	0	7,914	7,916
Tanker Tow	5	0	2,579	2,584
Tug/Tow Boat	0	0	4,858	4,858
Subzone Total:	495	1,678	27,107	29,280

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Appendix W ZONE 23 Mobile, AL

TABLE 6.2 Forecast 2000
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 2305F				
Passenger	0	0	259	259
Dry Cargo	442	1,483	632	2,557
Tanker	47	195	56	298
Dry Cargo Tow	2	0	5,141	5,142
Tanker Tow	5	0	1,397	1,401
Tug/Tow Boat	0	0	4,840	4,840
Subzone Total:	495	1,678	12,324	14,498

TABLE 6.3 Forecast 2005
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 2301A				
Passenger	0	0	6,536	6,536
Dry Cargo	738	2,105	9,340	12,183
Tanker	1,748	1,160	80	2,988
Dry Cargo Tow	2	0	7,870	7,873
Tanker Tow	103	0	5,831	5,934
Tug/Tow Boat	0	0	7,725	7,725
Subzone Total:	2,591	3,265	37,383	43,239
Subzone : 2302E				
Dry Cargo	222	406	3,541	4,169
Tanker	1,693	950	12	2,655
Dry Cargo Tow	0	0	706	706
Tanker Tow	98	0	3,524	3,622
Tug/Tow Boat	0	0	4,221	4,221
Subzone Total:	2,013	1,356	12,004	15,373
Subzone : 2303C				
Passenger	0	0	344	344
Dry Cargo	0	0	2,410	2,410
Dry Cargo Tow	0	0	26	26
Tanker Tow	0	0	1	1
Tug/Tow Boat	0	0	16	16
Subzone Total:	0	0	2,797	2,797
Subzone : 2304E				
Passenger	0	0	6,541	6,541
Dry Cargo	516	1,747	5,840	8,103
Tanker	55	221	68	344
Dry Cargo Tow	2	0	8,713	8,715
Tanker Tow	5	0	2,721	2,726
Tug/Tow Boat	0	0	5,321	5,321
Subzone Total:	578	1,968	29,204	31,750
Subzone : 2305F				
Passenger	0	0	268	268
Dry Cargo	516	1,747	743	3,006
Tanker	55	221	64	340
Dry Cargo Tow	2	0	5,659	5,661
Tanker Tow	5	0	1,440	1,445
Tug/Tow Boat	0	0	5,301	5,301
Subzone Total:	578	1,968	13,475	16,022

Appendix W ZONE 23 Mobile, AL

TABLE 6.4 Forecast 2010
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 2301A				
Passenger	0	0	6,765	6,765
Dry Cargo	863	2,483	10,612	13,958
Tanker	2,151	1,264	91	3,506
Dry Cargo Tow	2	0	8,661	8,664
Tanker Tow	111	0	6,264	6,375
Tug/Tow Boat	0	0	8,765	8,765
Subzone Total:	3,127	3,747	41,158	48,032
Subzone : 2302E				
Dry Cargo	259	471	4,223	4,953
Tanker	2,086	1,024	12	3,122
Dry Cargo Tow	0	0	770	770
Tanker Tow	105	0	3,815	3,921
Tug/Tow Boat	0	0	4,950	4,950
Subzone Total:	2,450	1,495	13,770	17,716
Subzone : 2303C				
Passenger	0	0	356	356
Dry Cargo	0	0	2,688	2,688
Dry Cargo Tow	0	0	28	28
Tanker Tow	0	0	1	1
Tug/Tow Boat	0	0	17	17
Subzone Total:	0	0	3,090	3,090
Subzone : 2304E				
Passenger	0	0	6,769	6,769
Dry Cargo	604	2,071	6,438	9,113
Tanker	65	252	79	396
Dry Cargo Tow	2	0	9,594	9,596
Tanker Tow	5	0	2,875	2,881
Tug/Tow Boat	0	0	5,844	5,844
Subzone Total:	677	2,323	31,599	34,599

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Appendix W ZONE 23 Mobile, AL

TABLE 6.4 Forecast 2010
Vessel Transits by Subzone, Vessel Type, and Size

Vessel Type	Large	Medium	Small	Total
Subzone : 2305F				
Passenger	0	0	278	278
Dry Cargo	604	2,071	878	3,553
Tanker	65	252	75	392
Dry Cargo Tow	2	0	6,231	6,233
Tanker Tow	5	0	1,488	1,493
Tug/Tow Boat	0	0	5,823	5,823
Subzone Total:	677	2,323	14,772	17,772

Appendix W ZONE 23 Mobile, AL

TABLE 6.5 Forecast 1995 - 2010 Vessel Transits by Vessel Type and Size

Vessel Type	Large	Medium	Small	Total
1995 FORECASTED ZONE TOTALS				
Passenger	0	0	5,726	5,726
Dry Cargo	487	1,423	6,984	8,894
Tanker	1,165	992	62	2,219
Dry Cargo Tow	2	0	7,787	7,788
Tanker Tow	88	0	5,457	5,545
Tug/Tow Boat	0	0	7,568	7,568
1995 Zone Total:	1,742	2,415	33,584	37,741
2000 FORECASTED ZONE TOTALS				
Passenger	0	0	6,027	6,027
Dry Cargo	530	1,545	7,430	9,505
Tanker	1,425	1,077	71	2,573
Dry Cargo Tow	2	0	8,562	8,564
Tanker Tow	95	0	5,834	5,929
Tug/Tow Boat	0	0	8,479	8,479
2000 Zone Total:	2,052	2,622	36,403	41,077
2005 FORECASTED ZONE TOTALS				
Passenger	0	0	6,238	6,238
Dry Cargo	620	1,749	8,113	10,482
Tanker	1,748	1,171	80	2,999
Dry Cargo Tow	2	0	9,418	9,420
Tanker Tow	103	0	6,245	6,348
Tug/Tow Boat	0	0	9,543	9,543
2005 Zone Total:	2,473	2,920	39,637	45,030
2010 FORECASTED ZONE TOTALS				
Passenger	0	0	6,456	6,456
Dry Cargo	725	2,065	9,187	11,977
Tanker	2,151	1,276	91	3,518
Dry Cargo Tow	2	0	10,363	10,366
Tanker Tow	111	0	6,691	6,801
Tug/Tow Boat	0	0	10,794	10,794
2010 Zone Total:	2,989	3,341	43,582	49,913

Note: Sum of all arrivals departures to/from all terminals within the study zone.

Appendix W Zone 23 Mobile, AL 7/25/91

TABLE 7 Vessel Casualty History (10 Year Totals) by Subzone, Vessel Type and Size, and Casualty Type

Vessel Type	Size	Collisions	Rammings	Groundings	Other	Total
Subzone: 2301A						
Passenger	Small	0	0	2	0	2
Dry Cargo Barge Tow	Small	0	0	1	0	1
Subzone Totals:		0	0	3	0	3
Subzone: 2302E						
Dry Cargo	Medium	0	0	1	0	1
Tanker	Large	1	0	2	0	3
Tanker	Small	1	0	0	0	1
Dry Cargo Barge Tow	Small	2	3	1	1	7
Tanker Barge Tow	Large	0	1	0	0	1
Tanker Barge Tow	Small	1	2	1	1	5
Tug/Tow Boat	Small	1	0	2	0	3
Fishing	Small	2	0	0	0	2
Other	Small	2	0	1	0	3
Subzone Totals:		10	6	8	2	26
Subzone: 2303C						
Dry Cargo	Small	0	0	1	0	1
Dry Cargo Barge Tow	Small	0	0	2	1	3
Tanker Barge Tow	Small	0	2	6	0	8
Tug/Tow Boat	Small	0	2	0	0	2
Fishing	Small	0	1	3	0	4
Subzone Totals:		0	5	12	1	18
Subzone: 2304E						
Passenger	Small	1	0	1	0	2
Dry Cargo	Large	2	0	4	0	6
Dry Cargo	Medium	0	1	2	0	3
Dry Cargo	Small	1	0	0	0	1
Dry Cargo Barge Tow	Small	6	15	0	1	22
Tanker Barge Tow	Large	1	0	0	0	1
Tanker Barge Tow	Small	7	0	5	0	12
Tug/Tow Boat	Small	2	1	0	0	3
Fishing	Small	3	1	1	0	5
Other	Small	3	1	1	0	5
Subzone Totals:		26	19	14	1	60

Note: OTHER equals barge breakaways and weather caused vessel casualties.

TABLE 7 Vessel Casualty History (10 Year Totals) by Subzone, Vessel Type and Size, and Casualty Type

Vessel Type	Size	Collisions	Rammings	Groundings	Other	Total
Subzone: 2305F						
Dry Cargo Barge Tow	Small	0	3	1	0	4
Tanker Barge Tow	Small	0	2	0	0	2
Tug/Tow Boat	Small	0	1	0	0	1
Other	Small	0	1	0	0	1
Subzone Totals:		0	7	1	0	8
Zone Totals:		36	37	38	4	115

Note: OTHER equals barge break ways and weather caused vessel casualties.

APPENDIX TABLE W-8 ZONE 23, MOBILE, AL - VTS LEVELS IN OPERATION

(Not Applicable to This Sub-Zone.)

APPENDIX TABLE W-9 ZONE 23, MOBILE, AL CANDIDATE VTS DESIGN - 1995-2010

UNITS

1	Radar Module 1	- Average Performance
0	Radar Module 2	- Average Performance
1	Radar Module 3	- High Performance
1	Radar Module 4	- High Performance
0	Radar Module 5	- Special Purpose
0	Radar Module 6	- Special Purpose
0	ADS Module 7	- Active Radar Transponder (Type 1)
0	ADS Module 8	- Positional Transponder, Small Area, Very High Accuracy (Type 5)
0	ADS Module 9	- Positional Transponder, Small Area, High Accuracy (Type 6)
4	VHF Module 10	- Low power VHF Transmitting/ Receiving Facility
2	VHF Module 11	- High power VHF Transmitting/ Receiving Facility
0	Meteorological Module 12	- Air temperature, wind direction and speed
0	Meteorological Module 13	- Air temperature, wind direction and speed, visibility
0	Hydrological Module 14	- Water Temperature and Depth
1	Hydrological Module 15	- Water Temperature, Depth and Current
0	VHF/DF MODULE 16	- Line of position measurement to 2 degree RMS
0	CCTV MODULE 17	- Fixed Focus CCTV via Telephone Lines
0	CCTV MODULE 18	- Remotely Controllable CCTV via

Appendix W   Zone 23 Mobile, AL

TABLE 10A   Avoided Vessel Casualties 1996 - 2010   7/31/91
Candidate VTS Systems

Counts

Vessel Type	Size	Collision	Ramming	Grounding	Total
Passenger	Small	.39	.06	.31	.76
Dry Cargo	Large	.63	.10	.66	1.39
Dry Cargo	Medium	.77	.12	.26	1.15
Dry Cargo	Small	1.15	.13	.17	1.44
Tanker	Large	2.08	.44	2.44	4.95
Tanker	Medium	.21	.02	.11	.33
Tanker	Small	.01	0.00	.01	.02
Dry Cargo Barge T	Large	.02	0.00	.01	.04
Dry Cargo Barge T	Small	12.85	3.75	4.19	20.80
Tanker Barge Tow	Large	.07	.03	.04	.14
Tanker Barge Tow	Small	7.23	1.21	3.97	12.41
Tug/Tow Boat	Small	.81	.26	.48	1.55
		26.21	6.11	12.65	44.97

Undiscounted Total Dollar Losses (1,000)

Vessel Type	Size	Collision	Ramming	Grounding	Total
Passenger	Small	344	49	198	592
Dry Cargo	Large	867	184	207	1,258
Dry Cargo	Medium	1,151	226	79	1,456
Dry Cargo	Small	831	96	109	1,036
Tanker	Large	30,724	6,623	21,900	59,247
Tanker	Medium	569	54	104	727
Tanker	Small	17	0	2	19
Dry Cargo Barge T	Large	2	0	0	3
Dry Cargo Barge T	Small	722	598	68	1,388
Tanker Barge Tow	Large	1,589	681	548	2,818
Tanker Barge Tow	Small	56,444	9,523	3,327	69,294
Tug/Tow Boat	Small	69	48	38	155
		93,329	18,082	26,581	137,992

Note: In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 11 Avoided Fatalities 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Small	.02	.00	.02	.05
Dry Cargo	Large	.08	.01	.08	.17
Dry Cargo	Medium	.10	.01	.03	.14
Dry Cargo	Small	.07	.01	.01	.09
Tanker	Small	.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	.03	.01	.01	.05
Tanker Barge Tow	Small	.02	.00	.01	.03
Tug/Tow Boat	Small	.00	.00	.00	.00
Totals		.32	.05	.17	.54
Candidate VTS Design - Dollars					
Passenger	Small	37,178.00	5,313.21	30,180.92	72,672.13
Dry Cargo	Large	118,736.02	18,737.13	124,035.40	261,508.55
Dry Cargo	Medium	145,424.30	21,772.86	48,787.44	215,984.60
Dry Cargo	Small	110,091.23	12,077.94	16,217.27	138,386.44
Tanker	Small	32.38	0.00	20.78	53.17
Dry Cargo Barge Tow	Small	42,485.34	12,405.16	13,863.04	68,753.54
Tanker Barge Tow	Small	23,910.70	4,008.72	13,123.03	41,042.45
Tug/Tow Boat	Small	2,663.49	866.52	1,594.55	5,124.55
Totals		480,521.45	75,181.53	247,822.43	803,525.42

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number [illegible] than [illegible] greater than 0.0000000 rounded to two decimal places. [illegible] rounding.

TABLE 12 Avoided Human Injuries 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Small	.29	.04	.24	.57
Dry Cargo	Large	.01	.00	.01	.02
Dry Cargo	Medium	.01	.00	.00	.02
Dry Cargo	Small	.87	.10	.13	1.09
Tanker	Small	.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	.31	.09	.10	.50
Tanker Barge Tow	Small	.18	.03	.10	.30
Tug/Tow Boat	Small	.02	.01	.01	.04
Totals		1.69	.27	.59	2.55
Candidate VTS Design - Dollars					
Passenger	Small	70,006.79	10,004.86	56,831.17	136,842.82
Dry Cargo	Large	2,038.67	321.71	2,129.66	4,490.03
Dry Cargo	Medium	2,496.90	373.83	837.67	3,708.40
Dry Cargo	Small	207,303.61	22,742.97	30,537.38	260,583.96
Tanker	Small	56.58	0.00	36.31	92.90
Dry Cargo Barge Tow	Small	74,235.23	21,675.71	24,223.09	120,134.03
Tanker Barge Tow	Small	41,779.51	7,004.50	22,930.05	71,714.05
Tug/Tow Boat	Small	4,653.95	1,514.08	2,786.18	8,954.20
Totals		402,571.24	63,637.65	140,311.50	606,520.39

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 13 Avoided Vessels Damaged 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Small	.33	.04	.10	.47
Dry Cargo	Large	.47	.07	.06	.60
Dry Cargo	Medium	.57	.08	.03	.68
Dry Cargo	Small	.98	.09	.09	1.16
Tanker	Large	1.57	.35	.32	2.24
Tanker	Medium	.16	.01	.01	.18
Tanker	Small	.00	0.00	.00	.00
Dry Cargo Barge Tow	Large	.02	0.00	.00	.02
Dry Cargo Barge Tow	Small	9.81	1.59	.58	11.98
Tanker Barge Tow	Large	.06	.02	.01	.09
Tanker Barge Tow	Small	5.52	.51	.55	6.58
Tug/Tow Boat	Small	.14	.03	.06	.23
Totals		19.63	2.79	1.82	24.24
Candidate VTS Design - Dollars					
Passenger	Small	112,477.60	12,564.04	50,593.51	175,635.15
Dry Cargo	Large	345,113.13	52,118.57	38,196.62	435,428.32
Dry Cargo	Medium	510,646.79	73,166.02	11,232.73	595,045.54
Dry Cargo	Small	186,515.66	16,638.64	22,712.10	225,866.40
Tanker	Large	1,233,079.60	276,337.50	688,227.53	2,197,644.64
Tanker	Medium	103,374.63	9,450.44	25,280.43	138,105.49
Tanker	Small	641.77	0.00	537.23	1,179.00
Dry Cargo Barge Tow	Large	2,399.37	0.00	296.44	2,695.81
Dry Cargo Barge Tow	Small	569,410.20	92,062.02	29,665.71	691,137.93
Tanker Barge Tow	Large	10,496.01	2,460.12	1,561.67	14,517.80
Tanker Barge Tow	Small	391,514.74	36,345.76	49,890.12	477,750.62
Tug/Tow Boat	Small	10,162.67	2,123.56	5,916.04	18,202.27
Totals		3,475,832.16	573,266.67	924,110.12	4,973,208.94

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 14 Avoided Cargo Damage/Loss 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Small	.09	.01	.03	.13
Dry Cargo	Large	.19	.04	.08	.31
Dry Cargo	Medium	.24	.04	.03	.31
Dry Cargo	Small	.45	.04	.04	.53
Tanker	Large	.64	.14	.33	1.11
Tanker	Medium	.06	.01	.01	.08
Tanker	Small	.00	0.00	.00	.00
Dry Cargo Tow	Large	.00	0.00	.00	.00
Dry Cargo Tow	Small	2.71	.79	.36	3.87
Tanker Tow	Large	.01	.00	.00	.02
Tanker Tow	Small	1.53	.26	.34	2.13
Tug/Tow Boat	Small	.07	.02	.02	.10
Totals		5.99	1.36	1.25	8.59
Candidate VTS Design - Dollars					
Passenger	Small	284.45	31.77	114.26	430.48
Dry Cargo	Large	1,776.83	397.25	175.52	2,349.60
Dry Cargo	Medium	2,176.20	461.61	69.04	2,706.86
Dry Cargo	Small	846.46	75.51	101.95	1,023.92
Tanker	Large	50,601.14	10,775.39	50,877.04	112,253.56
Tanker	Medium	908.73	81.40	194.99	1,185.11
Tanker	Small	10.39	0.00	3.84	14.24
Tanker Tow	Large	3,511.02	1,495.71	1,851.14	6,857.88
Tanker Tow	Small	119,675.95	20,043.23	26,756.11	166,475.29
Tug/Tow Boat	Small	122.33	25.56	69.32	217.21
Totals		179,913.51	33,387.44	80,213.20	293,514.15

Note1: Dollar values include bulk petroleum and chemical cargos only and all vessel fuels spilled. Dollar values exclude cargo loss/damage for non-tank vessel types.

Note2: In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 15 Avoided NavAid Damage 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Small	0.00	.01	.00	.01
Dry Cargo	Large	0.00	.01	.00	.02
Dry Cargo	Medium	0.00	.01	.00	.01
Dry Cargo	Small	0.00	.01	.00	.02
Tanker	Large	0.00	.05	.01	.06
Tanker	Medium	0.00	.00	.00	.00
Tanker	Small	0.00	0.00	.00	.00
Dry Cargo Barge Tow	Large	0.00	0.00	.00	.00
Dry Cargo Barge Tow	Small	0.00	.43	.02	.45
Tanker Barge Tow	Large	0.00	.00	.00	.00
Tanker Barge Tow	Small	0.00	.14	.02	.16
Tug/Tow Boat	Small	0.00	.03	.00	.03
Totals		0.00	.70	.07	.77
Candidate VTS Design - Dollars					
Passenger	Small	0.00	35.72	10.16	45.88
Dry Cargo	Large	0.00	64.30	21.31	85.61
Dry Cargo	Medium	0.00	74.72	8.38	83.10
Dry Cargo	Small	0.00	81.20	5.46	86.66
Tanker	Large	0.00	283.69	78.77	362.46
Tanker	Medium	0.00	11.52	3.47	14.99
Tanker	Small	0.00	0.00	.20	.20
Dry Cargo Barge Tow	Large	0.00	0.00	.47	.47
Dry Cargo Barge Tow	Small	0.00	2,422.55	135.53	2,558.07
Tanker Barge Tow	Large	0.00	19.49	1.26	20.76
Tanker Barge Tow	Small	0.00	782.84	128.29	911.14
Tug/Tow Boat	Small	0.00	169.22	15.59	184.81
Totals		0.00	3,945.26	408.90	4,354.15

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

TABLE 16 Avoided Bridge Damage 1996 - 2010

Vessel Type	Size	Collision	Ramming	Grounding	Total
Candidate VTS Design - Counts					
Passenger	Small	.00	.00	0.00	.00
Dry Cargo	Large	0.00	.01	0.00	.01
Dry Cargo	Medium	0.00	.01	0.00	.01
Dry Cargo	Small	.00	.01	0.00	.01
Tanker	Large	0.00	.05	0.00	.05
Tanker	Medium	0.00	.00	0.00	.00
Tanker	Small	.00	0.00	0.00	.00
Dry Cargo Barge Tow	Small	.02	.23	0.00	.25
Tanker Barge Tow	Large	0.00	.00	0.00	.00
Tanker Barge Tow	Small	.01	.08	0.00	.09
Tug/Tow Boat	Small	.00	.02	0.00	.02
Totals		.03	.42	0.00	.45
Candidate VTS Design - Dollars					
Passenger	Small	1,067.25	6,844.55	0.00	7,911.80
Dry Cargo	Large	0.00	23,001.25	0.00	23,001.25
Dry Cargo	Medium	0.00	26,751.98	0.00	26,751.98
Dry Cargo	Small	3,155.44	15,531.47	0.00	18,686.91
Tanker	Large	0.00	100,452.84	0.00	100,452.84
Tanker	Medium	0.00	4,094.17	0.00	4,094.17
Tanker	Small	26.99	0.00	0.00	26.99
Dry Cargo Barge Tow	Small	35,756.73	469,446.60	0.00	505,203.32
Tanker Barge Tow	Large	0.00	6,983.08	0.00	6,983.08
Tanker Barge Tow	Small	20,123.85	151,701.47	0.00	171,825.32
Tug/Tow Boat	Small	2,218.48	32,452.35	0.00	34,670.83
Totals		62,348.73	837,259.75	0.00	899,608.48

Note : In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

Appendix W   Zone 23 Mobile, AL
TABLE 17   Avoided Hazardous Commodity Spills 1996 - 2010   7/30/91

Commodity	Catastrophic	Large	Medium	Small	Total
Candidate Vts Design - Counts					
BENZENE AND TOLUENE	0.00	.01	.05	0.00	.06
ALCOHOLS	.00	.00	.01	.00	.01
SULPHUR, LIQUID	.00	.02	.06	.00	.07
KEROSENE	.00	.00	.00	.00	.00
RESIDUAL FUEL OIL	.01	.04	.43	.67	1.15
JET FUEL	.01	.03	.11	.01	.15
DISTILLATE FUEL OIL	.01	.05	.22	.42	.71
GASOLINE, INCL NATURAL	.03	.11	.48	.02	.63
CRUDE PETROLEUM	.14	.48	.30	.00	.93
	.20	.74	1.65	1.12	3.71

Note: In Counts, 0.00 equals 0.0000000; .00 represents a number less than 1 and greater than 0.0000000 rounded to two decimal places. Counts totals were calculated before rounding.

Appendix W Zone 23 Mobile, AL
TABLE 18A Annual Benefit & Cost Streams 7/31/91
Candidate VTS Systems

Discounted to 1993

Year	Investment ($1,000)	Operation & Maintenance ($1,000)	Benefits ($1,000)
1993	6,177	0	0
1996	0	410	5,952
1997	0	373	5,557
1998	0	339	5,185
1999	0	308	4,834
2000	0	280	4,505
2001	0	254	4,215
2002	0	231	3,942
2003	0	210	3,683
2004	0	191	3,439
2005	0	174	3,209
2006	0	158	3,008
2007	0	144	2,817
2008	0	131	2,635
2009	0	119	2,464
2010	0	108	2,302
	6,177	3,429	57,747

Undiscounted

Year	Investment ($1,000)	Operation & Maintenance ($1,000)	Benefits ($1,000)
1993	6,177	0	0
1996	0	521	7,562
1997	0	521	7,766
1998	0	521	7,970
1999	0	521	8,174
2000	0	521	8,379
2001	0	521	8,625
2002	0	521	8,872
2003	0	521	9,119
2004	0	521	9,366
2005	0	521	9,614
2006	0	521	9,911
2007	0	521	10,210
2008	0	521	10,509
2009	0	521	10,808
2010	0	521	11,107
	6,177	7,810	137,992

APPENDIX W

ZONE 23 - MOBILE, AL

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Mobile Port & Subzone	Species Category	Species Code	(Port 23) Species Name	Wildlife Abundance Tables Fish & Shellfish Grams per Square Meter Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
2301	102	40	Bank Cusk Eel	0.0000	.0473	0.0000	.0473
2301	102	42	Atlantic Thread Herring	.0606	.0606	.0606	.0306
2301	102	43	Ban Anchovy	.0047	.0047	.0047	.0047
2301	102	43	Striped Anchovy	.0158	.0158	.0158	.0158
2301	102	44	Striped Mullet	.9700	.9700	.9700	.9700
2301	102	128	Blackfin Searobin	.1316	.0658	.0658	.0658
2301	102	130	Planehead Filefish	.0316	.0316	.0526	0.0000
2301	102	238	Scaled Sardine	.0606	.0606	.0606	.0606
2301	105	17	Summer Flounder	.0380	.2500	.2100	.2300
2301	105	57	Channel Flounder	.1105	.1105	.1105	.1105
2301	105	57	Dusky Flounder	.0789	.1316	.1316	.1316
2301	105	57	Fringed Flounder	.1105	.3684	.5526	.1658
2301	105	57	Ocellated Flounder	.1105	.1105	.1105	.1105
2301	105	57	Shoal Flounder	.0553	.2302	.2763	.0553
2301	106	35	Atlantic Croaker	0.0000	14.8026	19.7368	.2947
2301	106	36	Banded Drum	.0473	.0473	.0473	.0473
2301	106	37	Spot	.0473	.2960	.1382	.1973
2301	106	40	Blackedge Cusk Eel	0.0000	0.0000	0.0000	.0473
2301	106	46	Spotted Sea Trout	1.9000	1.9000	1.9000	1.9000
2301	106	47	Sand Seatrout	0.0000	0.0000	.4489	.2565
2301	106	48	Hardhead Catfish	.1065	2.6644	.1065	3.5526
2301	106	65	Sheepshead	0.0000	.0950	.0950	0.0000
2301	106	69	Red Snapper	.4734	.4734	.4734	.4734
2301	106	71	Southern Hake	.0263	0.0000	0.0000	.0526
2301	106	71	Spotted Hake	.0316	0.0000	0.0000	0.0000
2301	106	76	Blackear Bass	.0552	.0552	.0552	.0552
2301	106	76	Rock Sea Bass	.9210	.1151	.0552	3.4539
2301	106	77	Gray Triggerfish	.0884	.0884	.0884	.0884
2301	106	91	Dwarf Sand Perch	.2368	.0987	.1973	.2368
2301	106	91	Sand Perch	0.0000	.0552	.0552	.1105
2301	106	128	Bighead Searobin	.0158	.0158	.0158	.0158
2301	106	128	Blackwing Searobin	.0316	.0789	.0526	0.0000
2301	106	128	Leopard Searobin	.0316	.0210	0.0000	.0526
2301	106	131	Round Scad	.0789	.0789	0.0000	0.0000
2301	106	134	Inshore Lizardfish	.1645	.1316	.1316	.1645
2301	106	134	Large Scale Lizardfish	.0473	.1973	0.0000	.0789
2301	106	134	Offshore Lizardfish	.0314	.0314	.0314	.0314
2301	106	239	Atlantic Bumper	.0159	.0159	.0159	.0159
2301	107	212	Oyster	5.2000	5.2000	5.2000	5.2000
2301	108	25	Brown Shrimp	.0138	.0089	.0069	.0024
2301	108	25	Pink Shrimp	.0138	.0039	.0039	.0024
2301	108	25	White Shrimp	0.0000	0.0000	.0016	.0024
2301	108	209	Blue Crab	4.4000	4.4000	4.4000	4.4000
2301	108	234	Rock Shrimp	.0092	.0053	.0016	.0016
2301	206	60	Long Spine Porgy	8.9802	19.2434	2.5657	7.6973
2301	206	73	Silver Jenny	0.0000	.0079	0.0000	.0118
2301	206	76	Bank Sea Bass	.0276	.0921	.0921	.1152
2301	206	241	Pigfish	0.0000	0.0000	0.0000	.0658
2302	102	40	Bank Cusk Eel	0.0000	.0473	0.0000	.0473
2302	102	42	Atlantic Thread Herring	.0606	.0606	.0606	.0606
2302	102	43	Ban Anchovy	.0047	.0047	.0047	.0047
2302	102	43	Striped Anchovy	.0158	.0158	.0158	.0158

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Mobile Port & Subzone	Species Category	(Port 23) Species Code	Species Name	Wildlife Abundance Tables Fish & Shellfish Grams per Square Meter Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
2302	102	44	Striped Mullet	.9700	.9700	.9700	.9700
2302	102	128	Blackfin Searobin	.1316	.0658	.0658	.0658
2302	102	130	Planehead Filefish	.0316	.0316	.0526	0.0000
2302	102	238	Scaled Sardine	.0606	.0606	.0606	.0606
2302	105	17	Summer Flounder	.0380	.2500	.2100	.2300
2302	105	57	Channel Flounder	.1105	.1105	.1105	.1105
2302	105	57	Dusky Flounder	.0789	.1316	.1316	.1316
2302	105	57	Fringed Flounder	.1105	.3684	.5526	.1658
2302	105	57	Ocellated Flounder	.1105	.1105	.1105	.1105
2302	105	57	Shoal Flounder	.0553	.2302	.2763	.0553
2302	106	35	Atlantic Croaker	0.0000	14.8026	19.7368	.2947
2302	106	36	Banded Drum	.0473	.0473	.0473	.0473
2302	106	37	Spot	.0473	.2960	.1382	.1973
2302	106	40	Blackedge Cusk Eel	0.0000	0.0000	0.0000	.0473
2302	106	46	Spotted Sea Trout	1.9000	1.9000	1.9000	1.9000
2302	106	47	Sand Seatrout	0.0000	0.0000	.4489	.2565
2302	106	48	Hardhead Catfish	.1065	2.6644	.1065	3.5526
2302	106	65	Sheepshead	0.0000	.0950	.0950	0.0000
2302	106	69	Red Snapper	.4734	.4734	.4734	.4734
2302	106	71	Southern Hake	.0263	0.0000	0.0000	.0526
2302	106	71	Spotted Hake	.0316	0.0000	0.0000	0.0000
2302	106	76	Blackear Bass	.0552	.0552	.0552	.0552
2302	106	76	Rock Sea Bass	.9210	.1151	.0552	3.4539
2302	106	77	Gray Triggerfish	.0884	.0884	.0884	.0884
2302	106	91	Dwarf Sand Perch	.2368	.0987	.1973	.2368
2302	106	91	Sand Perch	0.0000	.0552	.0552	.1105
2302	106	128	Bighead Searobin	.0158	.0158	.0158	.0158
2302	106	128	Blackwing Searobin	.0316	.0789	.0526	0.0000
2302	106	128	Leopard Searobin	.0316	.0210	0.0000	.0526
2302	106	131	Round Scad	.0789	.0789	0.0000	0.0000
2302	106	134	Inshore Lizardfish	.1645	.1316	.1316	.1645
2302	106	134	Large Scale Lizardfish	.0473	.1973	0.0000	.0789
2302	106	134	Offshore Lizardfish	.0314	.0314	.0314	.0314
2302	106	239	Atlantic Bumper	.0159	.0159	.0159	.0159
2302	107	212	Oyster	5.2000	5.2000	5.2000	5.2000
2302	108	25	Brown Shrimp	.0138	.0089	.0069	.0024
2302	108	25	Pink Shrimp	.0138	.0039	.0039	.0024
2302	108	25	White Shrimp	0.0000	0.0000	.0016	.0024
2302	108	209	Blue Crab	4.4000	4.4000	4.4000	4.4000
2302	108	234	Rock Shrimp	.0092	.0053	.0016	.0016
2302	206	60	Long Spine Porgy	8.9802	19.2434	2.5657	7.6973
2302	206	73	Silver Jenny	0.0000	.0079	0.0000	.0118
2302	206	76	Bank Sea Bass	.0276	.0921	.0921	.1152
2302	206	241	Pigfish	0.0000	0.0000	0.0000	.0658
2303	102	40	Bank Cusk Eel	0.0000	.0473	0.0000	.0473
2303	102	42	Atlantic Thread Herring	.0606	.0606	.0606	.0606
2303	102	43	Ban Anchovy	.0047	.0047	.0047	.0047
2303	102	43	Striped Anchovy	.0158	.0158	.0158	.0158
2303	102	44	Striped Mullet	.9700	.9700	.9700	.9700
2303	102	128	Blackfin Searobin	.1316	.0658	.0658	.0658
2303	102	130	Planehead Filefish	.0316	.0316	.0526	0.0000
2303	102	238	Scaled Sardine	.0606	.0606	.0606	.0606
2303	105	17	Summer Flounder	.0380	.2500	.2100	.2300
2303	105	57	Channel Flounder	.1105	.1105	.1105	.1105

APPENDIX W

ZONE 23 - MOBILE, AL (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Mobile Port & Subzone	Species Category	(Port 23) Species Code	Species Name	Wildlife Abundance Tables Fish & Shellfish Grams per Square Meter Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
2303	105	57	Dusky Flounder	.0789	.1316	.1316	.1316
2303	105	57	Fringed Flounder	.1105	.3684	.5526	.1658
2303	105	57	Ocellated Flounder	.1105	.1105	.1105	.1105
2303	105	57	Shoal Flounder	.0553	.2302	.2763	.0553
2303	106	35	Atlantic Croaker	0.0000	14.8026	19.7368	.2947
2303	106	36	Banded Drum	.0473	.0473	.0473	.0473
2303	106	37	Spot	.0473	.2960	.1382	.1973
2303	106	40	Blackedge Cusk Eel	0.0000	0.0000	0.0000	.0473
2303	106	46	Spotted Sea Trout	1.9000	1.9000	1.9000	1.9000
2303	106	47	Sand Seatrout	0.0000	0.0000	.4489	.2565
2303	106	48	Hardhead Catfish	.1065	2.6644	.1065	3.5526
2303	106	65	Sheepshead	0.0000	.0950	.0950	0.0000
2303	106	69	Red Snapper	.4734	.4734	.4734	.4734
2303	106	71	Southern Hake	.0263	0.0000	0.0000	.0526
2303	106	71	Spotted Hake	.0316	0.0000	0.0000	0.0000
2303	106	76	Blackear Bass	.0552	.0552	.0552	.0552
2303	106	76	Rock Sea Bass	.9210	.1151	.0552	3.4539
2303	106	77	Gray Triggerfish	.0884	.0884	.0884	.0884
2303	106	91	Dwarf Sand Perch	.2368	.0987	.1973	.2368
2303	106	91	Sand Perch	0.0000	.0552	.0552	.1105
2303	106	128	Bighead Searobin	.0158	.0158	.0158	.0158
2303	106	128	Blackwing Searobin	.0316	.0789	.0526	0.0000
2303	106	128	Leopard Searobin	.0316	.0210	0.0000	.0526
2303	106	131	Round Scad	.0789	.0789	0.0000	0.0000
2303	106	134	Inshore Lizardfish	.1645	.1316	.1316	.1645
2303	106	134	Large Scale Lizardfish	.0473	.1973	0.0000	.0789
2303	106	134	Offshore Lizardfish	.0314	.0314	.0314	.0314
2303	106	239	Atlantic Bumper	.0159	.0159	.0159	.0159
2303	107	212	Oyster	5.2000	5.2000	5.2000	5.2000
2303	108	25	Brown Shrimp	.0138	.0089	.0069	.0024
2303	108	25	Pink Shrimp	.0138	.0039	.0039	.0024
2303	108	25	White Shrimp	0.0000	0.0000	.0016	.0024
2303	108	209	Blue Crab	4.4000	4.4000	4.4000	4.4000
2303	108	234	Rock Shrimp	.0092	.0053	.0016	.0016
2303	206	60	Long Spine Porgy	8.9802	19.2434	2.5657	7.6973
2303	206	73	Silver Jenny	0.0000	.0079	0.0000	.0118
2303	206	76	Bank Sea Bass	.0276	.0921	.0921	.1152
2303	206	241	Pigfish	0.0000	0.0000	0.0000	.0658
2304	102	1	Alewife	.0010	.0010	.0010	.0010
2304	102	44	Mullet	4.9000	4.9000	4.9000	4.9000
2304	103	8	Bluefish	.4800	.0007	.4800	.3600
2304	103	11	Weakfish	.0015	.0015	.0015	.0015
2304	103	50	Bonito	.0300	.0300	.0300	.0300
2304	103	51	Jack	.0070	.0070	.0070	.0070
2304	103	52	Amberjack	.0300	.0300	.0300	.0300
2304	103	54	Blue Runner	.0070	.0070	.0070	.0070
2304	103	55	Doulphin	.0030	.0060	.0030	.0030
2304	104	12	Tuna	.0080	.0080	.0080	.0080
2304	104	13	Swordfish	.0280	.0280	.0280	.0280
2304	104	14	Shark	.0100	.0100	.0100	.0100
2304	105	17	Flounder	.0500	.0500	.0500	.0500
2304	106	4	Spotted Sea Trout	.0590	.0590	.0590	.0590
2304	106	28	Tilefish	.0390	.0390	.0390	.0390

APPENDIX W

ZONE 23 - MOBILE, AL (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Mobile Port & Subzone	Species Category	(Port 23) Species Code	Species Name	Wildlife Abundance Tables Fish & Shellfish Grams per Square Meter Spring Apr-Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
2304	106	29	Black Sea Bass	2.8000	2.8000	2.8000	2.8000
2304	106	40	Eel	.0011	.0011	.0011	.0011
2304	106	46	Sea Trout	.2300	.2300	.2300	.2300
2304	106	60	Porgies	.2000	.2000	.2000	.2000
2304	106	61	Florida Pompano	.0070	.0070	.0070	.0070
2304	106	62	Grunt	.0120	.0120	.0120	.0120
2304	106	65	Sheepshead	.0330	.0330	.0330	.0330
2304	107	212	Oyster	.3000	.3000	.3000	.3000
2304	107	235	Rangia	286.0000	286.0000	286.0000	286.0000
2304	108	209	Blue Crab	.4200	.4200	.4200	.4200
2304	108	215	Shrimp	.0570	.1200	.0480	.0180
2304	108	217	Crabs, other	.0010	.0010	.0010	.0010
2304	108	219	Spiny Lobster	.0450	.0450	.0450	.0450
2304	109	207	Squid	.0083	.0083	.0083	.0083
2305	102	1	Alewife	.0010	.0010	.0010	.0010
2305	103	8	Bluefish	.4800	.0007	.4800	.8600
2305	103	11	Weakfish	.0015	.0015	.0015	.0015
2305	103	50	Bonito	.0300	.0300	.0300	.0300
2305	103	51	Jack	.0070	.0070	.0070	.0070
2305	103	52	Amberjack	.0300	.0300	.0300	.0300
2305	103	54	Blue Runner	.0070	.0070	.0070	.0070
2305	103	55	Doulphin	.0030	.0060	.0030	.0030
2305	104	12	Tuna	.0080	.0080	.0080	.0080
2305	104	13	Swordfish	.0280	.0280	.0280	.0280
2305	104	14	Shark	.0100	.0100	.0100	.0100
2305	106	4	Spotted Sea Trout	.0590	.0590	.0590	.0590
2305	106	28	Tilefish	.0390	.0390	.0390	.0390
2305	106	29	Black Sea Bass	2.8000	2.8000	2.8000	2.8000
2305	106	40	Eel	.0011	.0011	.0011	.0011
2305	106	60	Porgies	.2000	.2000	.2000	.2000
2305	106	61	Florida Pompano	.0070	.0070	.0070	.0070
2305	106	62	Grunt	.0120	.0120	.0120	.0120
2305	107	235	Rangia	286.0000	286.0000	286.0000	286.0000
2305	108	217	Crabs, other	.0010	.0010	.0010	.0010
2305	108	219	Spiny Lobster	.0450	.0450	.0450	.0450
2305	109	207	Squid	.0083	.0083	.0083	.0083

APPENDIX W

ZONE 23 - MOBILE, AL (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Wildlife Abundances - Larvae

Mobile, AL	(Port 2300)			Number per Square Meter			
Area Code	Category Code	Species Code	Species Name	Spring Apr_Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
2304	203	1199	Larvae	12.2	11.6	0.55	0
2305	203	1199	Larvae	12.2	11.6	0.55	0
2304	204	1199	Larvae	0	0	0	0
2305	204	1199	Larvae	0	0	0	0
2304	205	1199	Larvae	5	5.8	0.58	5.8
2305	205	1199	Larvae	5	5.8	0.58	5.8
2304	207	1199	Larvae	20	200	200	0
2305	207	1199	Larvae	20	200	200	0
2304	208	1199	Larvae	0.016	0.042	0	0
2305	208	1199	Larvae	0.016	0.042	0	0
2304	206	1199	Elops Sauros	0	0	0	0.0366
2305	206	1199	Elops Sauros	0	0	0	0.0366
2304	202	1003	Menhaden	0.0366	0	0.0732	1.2627
2305	202	1003	Menhaden	0.0366	0	0.0732	1.2627
2304	202	1043	Anchoa Mitchili	53.07	311.1	2.196	4.026
2305	202	1043	Anchoa Mitchili	53.07	311.1	2.196	4.026
2304	206	1199	Strongylura sp.	0	0.0366	0	0
2305	206	1199	Strongylura sp.	0	0.0366	0	0
2304	202	1244	Pipefish	0.0549	0.0183	0	0.0915
2305	202	1244	Pipefish	0.0549	0.0183	0	0.0915
2304	206	1199	Diapters olisthostomus	0	0	0.0183	0
2305	206	1199	Diapters olisthostomus	0	0	0.0183	0
2304	206	1073	Mojarras	0.0183	0	0	0
2305	206	1073	Mojarras	0.0183	0	0	0
2304	206	1073	Mojarras (Gerreidae)	0.4941	2.013	0	0.00915
2305	206	1073	Mojarras (Gerreidae)	0.4941	2.013	0	0.00915
2304	206	1199	Bairdiella sp.	0.0915	0.475	0	0
2305	206	1199	Bairdiella sp.	0.0915	0.475	0	0
2304	206	1046	Sea Trout	0.22875	0.2379	0	0
2305	206	1046	Sea Trout	0.22875	0.2379	0	0
2304	206	1036	Drum	0.02745	0.04575	0	0.0183
2305	206	1036	Drum	0.02745	0.04575	0	0.0183
2304	206	1063	Pinfish	0	0	0	1.0065
2305	206	1063	Pinfish	0	0	0	1.0065
2304	206	1199	Dormitater maculatus	0.0183	0.00915	0.00915	0.0366
2305	206	1199	Dormitater maculatus	0.0183	0.00915	0.00915	0.0366
2304	206	1120	Naked Goby	0.2745	0.0549	0.0366	0.0732
2305	206	1120	Naked Goby	0.2745	0.0549	0.0366	0.0732
2304	206	1120	Clown Goby	0.2013	0.4941	0.0366	0.0732
2305	206	1120	Clown Goby	0.2013	0.4941	0.0366	0.0732
2304	206	1120	Goby	0.00915	0.183	0.00915	0.0183
2305	206	1120	Goby	0.00915	0.183	0.00915	0.0183
2304	202	1121	Blennius	0.0366	0.00915	0.0183	0
2305	202	1121	Blennius	0.0366	0.00915	0.0183	0

ZONE 23 - MOBILE, AL (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Wildlife Abundances - Larvae

Mobile, AL	(Port 2300)			Number per Square Meter			
Area Code	Category Code	Species Code	Species Name	Spring Apr_Jun	Summer Jul-Sep	Fall Oct-Dec	Winter Jan-Mar
2304	202	1127	Silverside	0.1281	0.0366	0.2196	0.0366
2305	202	1127	Silverside	0.1281	0.0366	0.2196	0.0366
2304	205	1242	Lined Sole	0.2562	0.366	0	0
2305	205	1242	Lined Sole	0.2562	0.366	0	0
2304	206	1245	Skillet Fish	0.0366	0	0	0.0549
2305	206	1245	Skillet Fish	0.0366	0	0	0.0549
2301	206	1035	Croaker	5	5	5	5
2302	206	1035	Croaker	5	5	5	5
2303	206	1035	Croaker	5	5	5	5
2301	202	1043	Anchovy	10	1	1	10
2302	202	1043	Anchovy	10	1	1	10
2303	202	1043	Anchovy	10	1	1	10
2301	202	1042	Herring	10	5	5	10
2302	202	1042	Herring	10	5	5	10
2303	202	1042	Herring	10	5	5	10
2301	204	1136	Tuna	0.1	0	0	0.1
2302	204	1136	Tuna	0.1	0	0	0.1
2303	204	1136	Tuna	0.1	0	0	0.1
2301	202	1033	Mackerel	5	1	1	5
2302	202	1033	Mackerel	5	1	1	5
2303	202	1033	Mackerel	5	1	1	5
2301	203	1199	Larvae	2.1	2	0.1	0
2302	203	1199	Larvae	2.1	2	0.1	0
2303	203	1199	Larvae	2.1	2	0.1	0
2301	204	1199	Larvae	2.1	0	0	0
2302	204	1199	Larvae	2.1	0	0	0
2303	204	1199	Larvae	2.1	0	0	0
2301	205	1199	Larvae	0.5	1	0.1	1
2302	205	1199	Larvae	0.5	1	0.1	1
2303	205	1199	Larvae	0.5	1	0.1	1
2301	207	1199	Larvae	2	20	2	0
2302	207	1199	Larvae	2	20	2	0
2303	207	1199	Larvae	2	20	2	0
2301	208	1199	Larvae	0.0016	0.0042	0	0
2302	208	1199	Larvae	0.0016	0.0042	0	0
2303	208	1199	Larvae	0.0016	0.0042	0	0

ZONE 23 - MOBILE, AL (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Wildlife Abundances - Birds

Mobile, AL (Port 2300)

Subzone	Category Code	Species Code	Species Name	Numbers per Square Kilometer Apr-Jun Spring	Jul-Sep Summer	Oct-Dec Fall	Jan-Mar Winter
2302	111	515	Bufflehead	0.1000	0.0000	0.1000	0.1000
2303	111	515	Bufflehead	0.1000	0.0000	0.1000	0.1000
2304	111	515	Bufflehead	0.1000	0.0000	0.1000	0.1000
2305	111	515	Bufflehead	0.1000	0.0000	0.1000	0.1000
2302	111	515	Ruddy Duck	0.05	0	0.05	0.05
2303	111	515	Ruddy Duck	0.05	0	0.05	0.05
2304	111	515	Ruddy Duck	0.05	0	0.05	0.05
2305	111	515	Ruddy Duck	0.05	0	0.05	0.05
2302	111	515	Ringneck Duck	0.05	0	0.05	0.05
2303	111	515	Ringneck Duck	0.05	0	0.05	0.05
2304	111	515	Ringneck Duck	0.05	0	0.05	0.05
2305	111	515	Ringneck Duck	0.05	0	0.05	0.05
2302	111	515	Common Goldeneye	0.01	0	0.01	0.01
2303	111	515	Common Goldeneye	0.01	0	0.01	0.01
2304	111	515	Common Goldeneye	0.01	0	0.01	0.01
2305	111	515	Common Goldeneye	0.01	0	0.01	0.01
2302	112	561	Snowy Egret	16.05	16.05	16.05	16.05
2303	112	561	Snowy Egret	16.05	16.05	16.05	16.05
2304	112	561	Snowy Egret	16.05	16.05	16.05	16.05
2305	112	561	Snowy Egret	16.05	16.05	16.05	16.05
2302	112	561	Great Common Egret	17.65	17.65	17.65	17.65
2303	112	561	Great Common Egret	17.65	17.65	17.65	17.65
2304	112	561	Great Common Egret	17.65	17.65	17.65	17.65
2305	112	561	Great Common Egret	17.65	17.65	17.65	17.65
2302	113	546	American White Pelican	23.95	23.95	23.95	23.95
2303	113	546	American White Pelican	23.95	23.95	23.95	23.95
2304	113	546	American White Pelican	23.95	23.95	23.95	23.95
2305	113	546	American White Pelican	23.95	23.95	23.95	23.95
2302	112	564	White-faced Ibis	15.95	15.95	15.95	15.95
2303	112	564	White-faced Ibis	15.95	15.95	15.95	15.95
2304	112	564	White-faced Ibis	15.95	15.95	15.95	15.95
2305	112	564	White-faced Ibis	15.95	15.95	15.95	15.95
2302	112	564	White Ibis	11.65	11.65	11.65	11.65
2303	112	564	White Ibis	11.65	11.65	11.65	11.65
2304	112	564	White Ibis	11.65	11.65	11.65	11.65
2305	112	564	White Ibis	11.65	11.65	11.65	11.65
2302	112	561	Great Blue Heron	4.45	4.45	4.45	4.45
2303	112	561	Great Blue Heron	4.45	4.45	4.45	4.45
2304	112	561	Great Blue Heron	4.45	4.45	4.45	4.45
2305	112	561	Great Blue Heron	4.45	4.45	4.45	4.45
2302	112	561	Little Blue Heron	5.2	5.2	5.2	5.2
2303	112	561	Little Blue Heron	5.2	5.2	5.2	5.2
2304	112	561	Little Blue Heron	5.2	5.2	5.2	5.2
2305	112	561	Little Blue Heron	5.2	5.2	5.2	5.2

ZONE 23 - MOBILE, AL (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Wildlife Abundances - Birds

Mobile, AL	(Port 2300)			Numbers per Square Kilometer			
Subzone	Category Code	Species Code	Species Name	Apr-Jun Spring	Jul-Sep Summer	Oct-Dec Fall	Jan-Mar Winter
2302	112	561	Louisiana Heron	2.05	2.05	2.05	2.05
2303	112	561	Louisiana Heron	2.05	2.05	2.05	2.05
2304	112	561	Louisiana Heron	2.05	2.05	2.05	2.05
2305	112	561	Louisiana Heron	2.05	2.05	2.05	2.05
2302	111	511	Gadwall	51.1	0	51.1	51.1
2303	111	511	Gadwall	51.1	0	51.1	51.1
2304	111	511	Gadwall	51.1	0	51.1	51.1
2302	111	512	American Coot	112.1	0	112.1	112.1
2303	111	512	American Coot	112.1	0	112.1	112.1
2304	111	512	American Coot	112.1	0	112.1	112.1
2302	111	511	Blue winged teal	48.15	0	48.15	48.15
2303	111	511	Blue winged teal	48.15	0	48.15	48.15
2304	111	511	Blue winged teal	48.15	0	48.15	48.15
2302	111	511	Mallard	17.15	0	17.15	17.15
2303	111	511	Mallard	17.15	0	17.15	17.15
2304	111	511	Mallard	17.15	0	17.15	17.15
2302	111	511	Northern Pintail	32.5	0	32.5	32.5
2303	111	511	Northern Pintail	32.5	0	32.5	32.5
2304	111	511	Northern Pintail	32.5	0	32.5	32.5
2302	111	511	Green Winged Teal	9.4	0	9.4	9.4
2303	111	511	Green Winged Teal	9.4	0	9.4	9.4
2304	111	511	Green Winged Teal	9.4	0	9.4	9.4
2302	111	511	Mottled Duck	8.2	0	8.2	8.2
2303	111	511	Mottled Duck	8.2	0	8.2	8.2
2304	111	511	Mottled Duck	8.2	0	8.2	8.2
2302	111	511	Northern Shoveler	6.95	0	6.95	6.95
2303	111	511	Northern Shoveler	6.95	0	6.95	6.95
2304	111	511	Northern Shoveler	6.95	0	6.95	6.95
2302	111	511	American Wigeon	2.3	0	2.3	2.3
2303	111	511	American Wigeon	2.3	0	2.3	2.3
2304	111	511	American Wigeon	2.3	0	2.3	2.3
2302	111	515	Red Breasted Merganser	1.05	0	1.05	1.05
2303	111	515	Red Breasted Merganser	1.05	0	1.05	1.05
2304	111	515	Red Breasted Merganser	1.05	0	1.05	1.05
2302	111	515	Hooded Merganser	0.95	0	0.95	0.95
2303	111	515	Hooded Merganser	0.95	0	0.95	0.95
2304	111	515	Hooded Merganser	0.95	0	0.95	0.95
2302	111	515	Scaup	0.65	0	0.65	0.65
2303	111	515	Scaup	0.65	0	0.65	0.65
2304	111	515	Scaup	0.65	0	0.65	0.65
2302	112	561	Cattle Egret	0.76	0.76	0.76	0.76
2303	112	561	Cattle Egret	0.76	0.76	0.76	0.76
2304	112	561	Cattle Egret	0.76	0.76	0.76	0.76

ZONE 23 - MOBILE, AL (Cont.)

STUDY SUB-ZONE MARINE SPECIES ABUNDANCE - INPUT DATA FOR NRDAM/CME MODEL

Wildlife Abundances - Birds

Mobile, AL (Port 2300)

Subzone	Category Code	Species Code	Species Name	Apr-Jun Spring	Jul-Sep Summer	Oct-Dec Fall	Jan-Mar Winter
				Numbers per Square Kilometer			
2305	112	561	Cattle Egret	0.76	0.76	0.76	0.76
2302	112	561	Black-crowned Night Heron	1.05	1.05	1.05	1.05
2303	112	561	Black-crowned Night Heron	1.05	1.05	1.05	1.05
2304	112	561	Black-crowned Night Heron	1.05	1.05	1.05	1.05
2305	112	561	Black-crowned Night Heron	1.05	1.05	1.05	1.05
2302	112	561	Reddish Egret	0.02	0.02	0.02	0.02
2303	112	561	Reddish Egret	0.02	0.02	0.02	0.02
2304	112	561	Reddish Egret	0.02	0.02	0.02	0.02
2305	112	561	Reddish Egret	0.02	0.02	0.02	0.02
2302	113	546	Brown Pelican	0.01	0.01	0.01	0.01
2303	113	546	Brown Pelican	0.01	0.01	0.01	0.01
2304	113	546	Brown Pelican	0.01	0.01	0.01	0.01
2305	113	546	Brown Pelican	0.01	0.01	0.01	0.01
2302	112	570	Shorebirds	109	43.8	50.4	478
2303	112	570	Shorebirds	109	43.8	50.4	478
2304	112	570	Shorebirds	109	43.8	50.4	478
2305	112	570	Shorebirds	109	43.8	50.4	478
2301	113	530	Seabirds	2.3	2.3	2.3	2.3

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The Port Needs Study - Vessel Traffice Services Benefits is documented in three separately bound volumes. Volume I is the main document covering all aspects of the inputs, analyses and results. Volume II contains the appendix tables of input data and output statistics and the details of the Candidate VTS Design for each study zone. Volume III is a compendium of technical papers covering data, analytical methods and models supplementing the material in Volume I. All three volumes are available from the National Technical Information Service, Springfield, VA 22161.

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Purpose

This study documents the benefits and costs of potential U.S. Coast Guard Vessel Traffic Services (VTS) in selected U.S. deep draft ports on the Atlantic, Gulf and Pacific coasts. The U.S. Department of Transportation, Research and Special Programs Administration (RSPA), Volpe National Transportation Systems Center (VNTSC) conducted the study for the U.S. Coast Guard, Office of Navigation Safety and Waterway Services, Special Projects Staff. The study started in February 1990 as a Coast Guard initiative, prior to the passage of the "The Oil Pollution Act of 1990" (Public Law 101-380). This initiative satisfies the requirements of the Act.

Background

The concept of VTS has gained international acceptance by governments and maritime industries, as a means of advancing safety in rapidly expanding ports and waterways. Vessel Traffic Services work through position and situation advisory communications with vessels navigating the waterways. VTS communications are advisory in nature, providing timely and accurate information to the mariner, thus enhancing the potential for avoiding vessel casualties. VTS do not exercise direct control by ordering specific course directions or speeds to maneuver around hazards. "While the Vessel Control Center (VTC) will have the authority to direct the movement of a vessel in a dangerous situation, a master remains responsible for the safe and prudent manuevering of the vessel at all times."[1]

Several spills following within three months of the Prince William Sound incident of March 1989 (i.e., one in the coastal waters of Rhode Island, one in the Delaware River, and one in the Houston Ship Channel) drew intense congressional interest and resulted in the passage of "The Oil Pollution Act of 1990" (Public Law 101-380) on August 18, 1990. The Act requires the "Secretary to conduct a study...to determine and prioritize the U.S. ports and channels that are in need of new, expanded, or improved vessel traffic service systems... ." The Act further requires that the results of the study be submitted to Congress not later than one year after enactment of the Act.

Several studies have been performed prior to this study:

1. The USCG Study Report - Vessel Traffic Systems Analysis of Port Needs (August 1973)
2. The BMC Hong Kong VTS Study, Operational Solutions and Alternatives, Volume II, Site Configuration and Equipment Analysis (June 1984)
3. The European Economic Community Study-COST 301, (June 1987)
4. The Canadian Ministry of Supply and Services, Bureau of Management Consulting (BMC) Study- Vessel Traffic Services (October 1984) and Update Study (February 1988)

This study builds upon the experience of the earlier efforts and provides the most comprehensive quantitative analysis to date of VTS benefits and costs.

Approach

This study analyzes historical vessel casualties and their consequences and projects future vessel casualties and consequences for 23 study zones. The study uses a benefit-cost approach and focuses on navigational risk measured in terms of probabilities of vessel collisions, rammings or groundings, and the human and environmental consequences and economic losses that attend vessel casualties. VTS benefits are defined as the avoided vessel casualties and the associated

1 Federal Register, Vol. 55, No. 166, August 27, 1990, Rules and Regulations pg. 34909

Approach *(cont'd.)*

consequences. The avoided consequences are measured in physical units and are assigned monetary values. VTS costs are defined as the initial federal investment for a state of the art VTS system in each study zone and its annual operating and maintenance costs. A candidate VTS Design in each study zone is projected to reduce the risk of vessel casualties and their consequences during the period 1996 - 2010.

The study approach consists of the following seven steps:

1. Defining study zones and subzones.
2. Analyzing historical vessel casualties.
3. Forecasting avoidable future vessel casualties in each study zone.
4. Estimating the avoidable consequences in each study zone, the associated physical losses, and the dollar values of these avoidable losses.
5. Estimating the cost of a state-of-the-art Candidate VTS Design for each study zone.
6. Comparing the benefits and costs among the 23 study zones.
7. Analysis of sensitivity of relative net benefits among the study zones to a range of uncertainty in key input variables.

The VTS Benefits =

Forecasted Vessel Transits x
Probability of a Vessel Casualty x
VTS Effectiveness x
Probability of a Consequence x
Probability of Consequence Severity x
Unit Dollar Value of the Consequence

The life cycle annual stream of dollar values of benefits are discounted (at 10% per year) and are compared to the discounted annual stream of VTS costs to provide the Net Benefits for each study zone.

Study Zones and Subzones

After consulting with each of the Regional Offices, Captains of The Port, and headquarters personnel, the Coast Guard Special Projects Staff selected the 23 study zones to be analyzed as shown on the map in Figure 1.

Each study zone incorporates at least one major port, at least one major navigational challenge, and at least one environmentally sensitive area. In total, the boundaries of the 23 study zones encompass 82 deep draft ports, which load and unload over 80% of the U.S. total international and domestic cargo vessel tonnage, and enclose approximately 64% of the 1979-1989 vessel casualties in U.S. waters that were potentially VTS addressable.

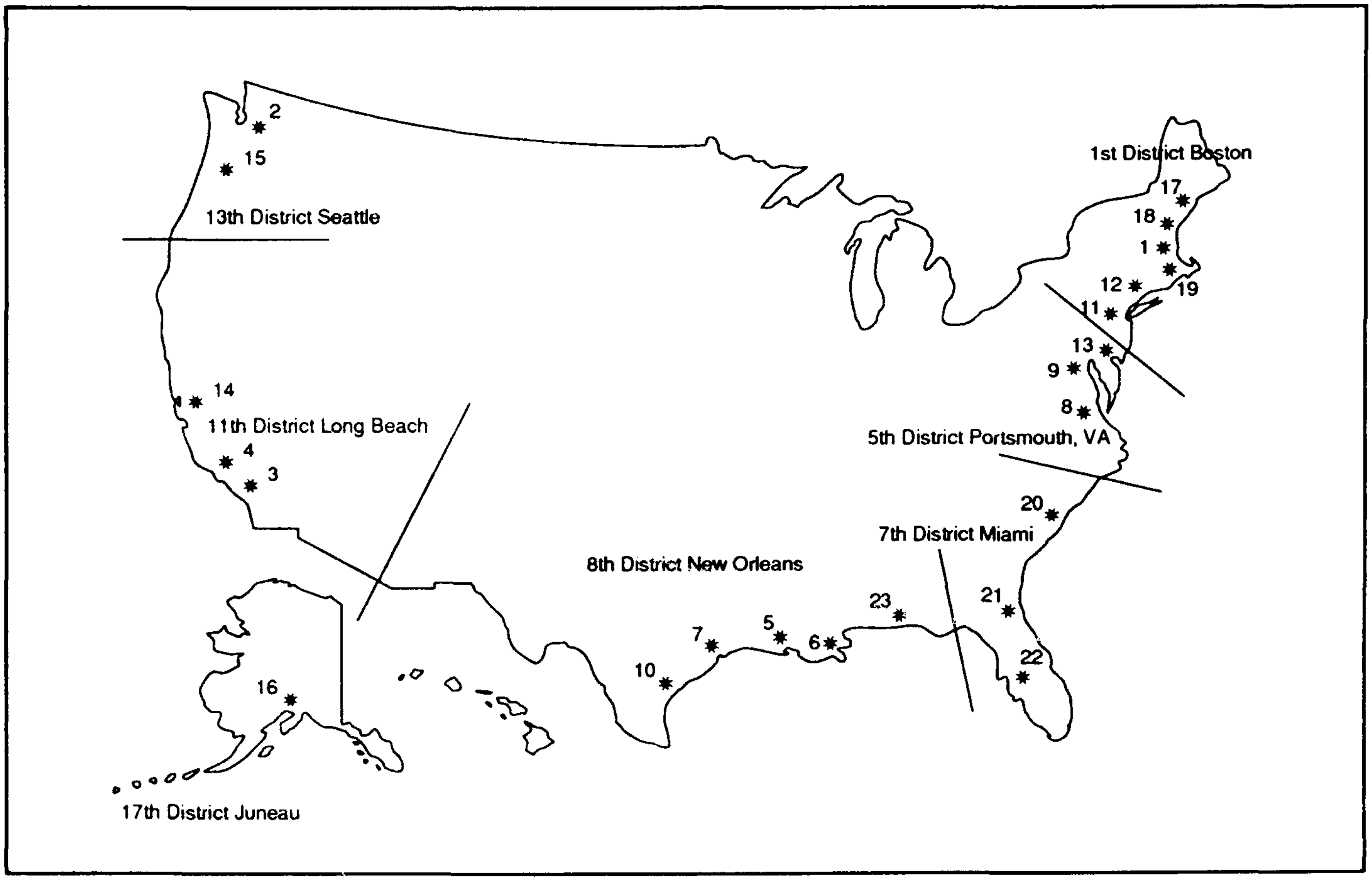
In order to perform a zone-by-zone evaluation, the following generic subzone (waterbody) types are established. Each subzone type characterizes the common navigational attributes of the waterways within each study zone.

1. Open Approach
2. Convergence
3. Open Harbor or Bay
4. Enclosed Harbor
5. Constricted Waterway
6. River

Using these waterbody types, the 23 study zones are divided into a total of 99 subzones for all the analyses.

Vessel Casualties

Historical casualties are analyzed to develop an understanding of the causes, circumstances and consequences of vessel casualties and to aid in modeling navigational risk and the estimation of casualties which would be avoided by operation of a VTS system. From the Coast Guard central file, 36,000 vessel casualty records are within the 23 study zone boundaries for the period 1979 to 1989;



Study Zone Code	Study Zone Name	Study Zone Code	Study Zone Name
1	Boston, MA	12	Long Island Sound, NY
2	Puget Sound, WA	13	Philadelphia/Delaware Bay, PA
3	Los Angeles/Long Beach, CA	14	San Francisco, CA
4	Santa Barbara, CA	15	Portland, OR
5	Port Arthur, TX	16	Anchorage/Cook Inlet, AK
6	New Orleans, LA	17	Portland, ME
7	Houston/Galveston, TX	18	Portsmouth, NH
8	Chesapeake South/Hampton Roads, VA	19	Providence, RI
9	Chesapeake North/Baltimore, MD	20	Wilmington, NC
10	Corpus Christi, TX	21	Jacksonville, FL
11	New York City, NY	22	Tampa, FL
		23	Mobile, AL

Figure 1. VTS Study Zones

Vessel Casualties *(cont'd.)*

a total of 2,210 are selected as "VTS addressable." These are casualties that are considered to be "addressable" by the Coast Guard Candidate VTS system.

- Addressable Incidents
  - Open water collisions between two vessels caused by surprise, poor visibility, severe weather, or simple miscalculation on the bridge.
  - Certain overtaking situations.
  - Collisions during situations when vessels are not anchored in confined waters where the vessel enters a congested channel or waterway directly from the pier, dock, or anchorage.
  - Casualties at dredging operations or at similar work activities in a channel.
  - Some casualties involving vessels at anchorage.
- Unaddressable Incidents
  - Mechanical failure, fire or explosion.
  - Non-participating vessels (i.e., fishing vessels and other vessels less than 20 meters in length).
  - Casualties outside of the VTS range of surveillance.
  - Grounding or collisions in close-quarter situations such as docking, undocking, maneuvering in a crowded anchorage.
  - Incidents which occur with insufficient warning or lead time (e.g., micro bursts).

Forecasting Future Vessel Casualties

Vessel Traffic

Vessel exposure to potential vessel casualty is measured in terms of the number of vessel transits. Vessel transits are estimated by vessel type and size moving within each of the 99 study subzones. Vessel transits for the years 1996-2010 are forecast by applying growth rates of the cargos carried by each of the several vessel types. Consideration is given to the changes in vessel sizes through the study period.

Navigational Risk

Navigational risk is represented by the number of VTS addressable casualties (collisions, groundings, and rammings), per hundred thousand vessel transits, by vessel type and size for each study subzone.

The approach taken is to develop national average vessel casualty rates for VTS addressable vessel casualties, estimated by vessel type and casualty type. The historical casualty rates for subzones with operating VTS services are adjusted to account for the beneficial effect of existing systems. They are then aggregated across all subzones and divided by the appropriate vessel transits to develop national average vessel casualty rates by casualty type, vessel type, and vessel size.

In order to produce vessel casualty probabilities representing each of 99 specific subzones, the national average casualty rates are modified by subzone risk adjustment factors that reflect local navigational characteristics. The subzone adjustment factors are generated by a multiple regression analysis of statistically significant navigational variables common to all subzones. These variables are used to represent the unique navigational characteristics in each subzone.

Forecasting Future Vessel Casualties *(cont'd.)*

The subzone probabilities of vessel casualties (by casualty type, vessel type, and vessel size) are then estimated by multiplying the national average vessel casualty rates by the subzone risk adjustment factors.

Projecting Avoidable . uture Vessel Casualties

Application of the vessel casualty probabilities to the traffic forecasts permits the estimation of the probable number of future vessel casualties in each subzone excluding the VTS effects. In order to project future avoided casualties attributable to the Candidate VTS Design, VTS Effectiveness Factors reflecting different navigational situations, vessel sizes and VTS levels of technology are applied.

Estimating Avoidable Consequences, Physical Units and Dollar Values

Given estimates of vessel casualties, conditional probabilities of consequences and their respective severity levels are applied. The consequences associated with the avoided casualties are measured in physical terms and then converted to dollar values for benefit-cost analysis. The dollar values of all avoided future consequences over the 15-year life cycle are discounted back to the year of the initial investment (1993) for comparison with discounted VTS costs.

The following types of consequence are estimated using conditional probabilities derived fr historical data:

Vessel Damage - These damage losses cover the repair charges as well as the opportunity costs of the idle vessels during their repair. An overall average of 40% of vessel casualties result in vessel damage.

Human Deaths/Human Injuries - An overall average of 3% of vessel casualties result in deaths and 10% in injuries.

Cargo Damage and Loss - An overall average of 11% of all vessel casualties suffer damage/loss to the cargo.

Navigational Aid Damage - The results of the analysis indicate that vessel rammings have an overall 2% probability of causing NAVAID damage.

Bridge Damage - The overall probability of bridge damage is 1% of the total vessel casualties.

Emergency Response - The Coast Guard responds to every casualty that is reported. The dollar value of these emergency responses is estimated by type of vessel and type of response required.

Hazardous Commodity Spills and Associate Losses - Environmental losses and economic losses occur when there are spills of hazardous commodities. The overall probability of hazardous spills of bulk cargos from tankers and tank barges is estimated to be 13% of these vessel casualties.

Environmental/Marine Life Loss

Estimates of avoided environmental/marine losses are provided in terms of their physical dimensions (e.g., the number of marine mammals and birds, quantity of commercial fish species lost) and their respective dollar values.

The spill damage assessment of various hazardous commodities on the environment and marine life is supported by the Natural Resource Damage Assessment Model for Coastal and Marine Environments (NRDAM/CME) developed by U.S. Department of the Interior. The model has been modified and applied to represent the marine species found in each of the 23 study zones. The model estimates the pounds of commercial fish species destroyed, the numbers of birds and mammals, and the economic value of these losses.

Scenarios are developed of hazardous commodity spills in each subzone, reflecting average conditions under which the spills might occur. The results for each subzone are reported in terms of the quantity and the total dollar value of all species lost per spill by subzone, hazardous commodity spilled, and spill size.

Estimating Avoidable Consequences, Physical Units and Dollar Values *(cont'd.)*

Decrease in Tourism, Recreational and Commercial Use and Value of Shoreline Properties

When spills take place, losses occur in tourism and recreational uses of coastal shoreline and waters and in the perceived value of shoreline properties that have been fowled. A model predicts the spill-related tourism and recreational losses due to spills of crude oil. Property value losses are based on rental income loss due to spills of crude oil, petroleum products, and chemicals.

Cleanup Activities

Spills of crude oil, petroleum products, and chemicals require extensive cleanup efforts to minimize their effects on the environment. Cleanup costs for several sizes of spills are estimated.

Damage Assessment

When a spill occurs, those responsible must compensate the government and the injured parties for damages to environmental resources, and for clean-up costs. They must also reimburse the federal government (DOI or NOAA) and/or state environmental agencies for their expenses in assessing the damages. Estimates of the costs of preparing these damage assessments are made for each spill size.

Liquified Natural Gas (LNG) and Liquified Petroleum Gas (LPG) Explosions

Estimates are developed of the type and amount of damage resulting from explosion and fire following a release of LNG and LPG, given the type of vessel casualty and the location of the casualty. The estimates include the damages to the tankers and their crew, other vessels and crew, local populations and structures on shore.

VTS Candidate Designs and Costs

The basic concept of the "Candidate VTS Design" includes a state of the art central data gathering and watch standing facility, known as a Vessel Traffic Center, and an array of state-of-the-art surveillance sensors covering each subzone. The Candidate VTS Design has as its objective the timely and accurate communication of critical navigational information to the bridge of participating vessels minimizing the risk of vessel casualties. The unique characteristics of each subzone dictate how many and what type of surveillance sensors (radar, television, communications, automatic dependent surveillance [ADS], etc.) support the Vessel Traffic Center.

A survey of state of the art VTS technology resulted in a list of 18 modules of surveillance and communications technologies ranging from high performance radar to closed circuit TV. The Candidate VTS Design for each study zone is defined by a unique selection of these modules. The appropriate surveillance modules are selected on the basis of engineering judgment of the local requirements for the purpose of developing cost estimates that are consistent and comparable among the 23 study zones. The costs of the Candidate VTS Design are then estimated, including non-recurring *initial capital investment* and recurring operations and maintenance costs. Initial capital investments range from $3.3 million for Portsmouth, NH, to $25.5 million for New Orleans. In the four study zones where there are existing Coast Guard VTS services, selected existing facilities are incorporated into the Candidate VTS Design, thus reducing the initial investment cost for those zones.

Evaluation of VTS Benefits and Costs

The final product of this study is the estimated net benefit of a Candidate VTS Design in each of 23 study zones. The net benefit is the difference between the 1993 value of the life cycle benefits and costs.

The net benefit in each study zone assumes that the decision to implement is made and that the funds are appropriated in FY '93. The Candidate VTS Design is assumed to be fully operational (accruing operations and maintenance costs as well as

Evaluation of VTS Benefits and Costs *(cont'd)*

benefits) by the beginning of FY '96. The life cycle period is assumed to run through FY 2010.

Two perspectives are analyzed and compared:

1) The full benefits and costs of the Candidate VTS Design, i.e., ignoring any existing VTS services.

2) The marginal benefits and costs of the Candidate VTS Design (acknowledging the benefits and costs of Existing VTS Services) that would accrue if the existing system continued unchanged into the future.

These Existing VTS Services include Coast Guard VTS systems and commercial VTS-like services.

Full VTS Benefits and Costs

The full benefits can be viewed as the difference between the projected casualties in an unimproved study zone and the casualties with a Candidate VTS Design (i.e., the Avoided Casualties). The full benefits can be estimated by application of VTS Effectiveness Factors to the projected vessel casualties and associated consequences/losses of the unimproved situation. The full costs of the Candidate VTS Design are the "Clean Sheet" costs (i.e., no existing facilities incorporated into the Candidate VTS Design). The benefits and costs of all 23 study zones are estimated this way, and they are compared on this basis.

Marginal VTS Benefits and Costs

Marginal benefits and marginal costs are defined for assessing the benefits and costs of the Candidate VTS Design over the *status quo* in those study zones where existing vessel traffic services are currently in operation. Marginal benefits are developed for those study zones by estimating *the differences* in the Candidate VTS Design avoided vessel casualties and the avoided vessel casualties if the Existing VTS system continues unchanged into the future. This difference is defined as the marginal benefit. The marginal VTS Costs are defined to incorporate both the incremental investment associated with utilization of certain existing Coast Guard facilities (e.g., radar facilities in Puget Sound) into the Candidate VTS Design and the differences in the annual operation and maintenance costs.

Projected VTS Benefits

The following sections present the national aggregate benefits for the 15-year period, 1996-2010 and the study zones ranked by each major benefit type. The figures present both the Full Benefit and the Marginal Benefit for each study zone.

In order to assess the overall value of the Candidate VTS Design in all 23 study zones to the nation as a whole, the national total physical losses, the undiscounted dollar values, and the 1993 discounted value of the net benefits are examined in sequence. It is informative to view several of the major loss categories at the national aggregate level prior to considering the ranking of the individual study zones by the 1993 value of the net benefits.

In the nine study zones that had operating Existing VTS Systems during 1990, the upper bar on each figure indicates the Full Benefit of the Candidate VTS Design, and the lower bar indicates the Marginal Benefit.

Avoided Vessel Casualties

The Candidate VTS Designs for the 23 study zones are projected to avoid a total of 980 vessel casualties during the 15-year period. This represents a 29% decrease in addressable vessel casualties than would occur without any VTS. VTS is more effective in avoiding collisions than it is in avoiding rammings and groundings. Therefore, 53% of the avoided vessel casualties are collisions. Rammings and groundings represent a combined total of 47% of the avoided vessel casualties.

Figure 2 displays the 23 study zones in descending order of avoided vessel casualties. New Orleans overwhelmingly leads with 4.5 times as many as Port Arthur. In New Orleans, 56% of the avoided vessel casualties involve barge tows (i.e., 33% barge collisions and 23% barge rammings and groundings).

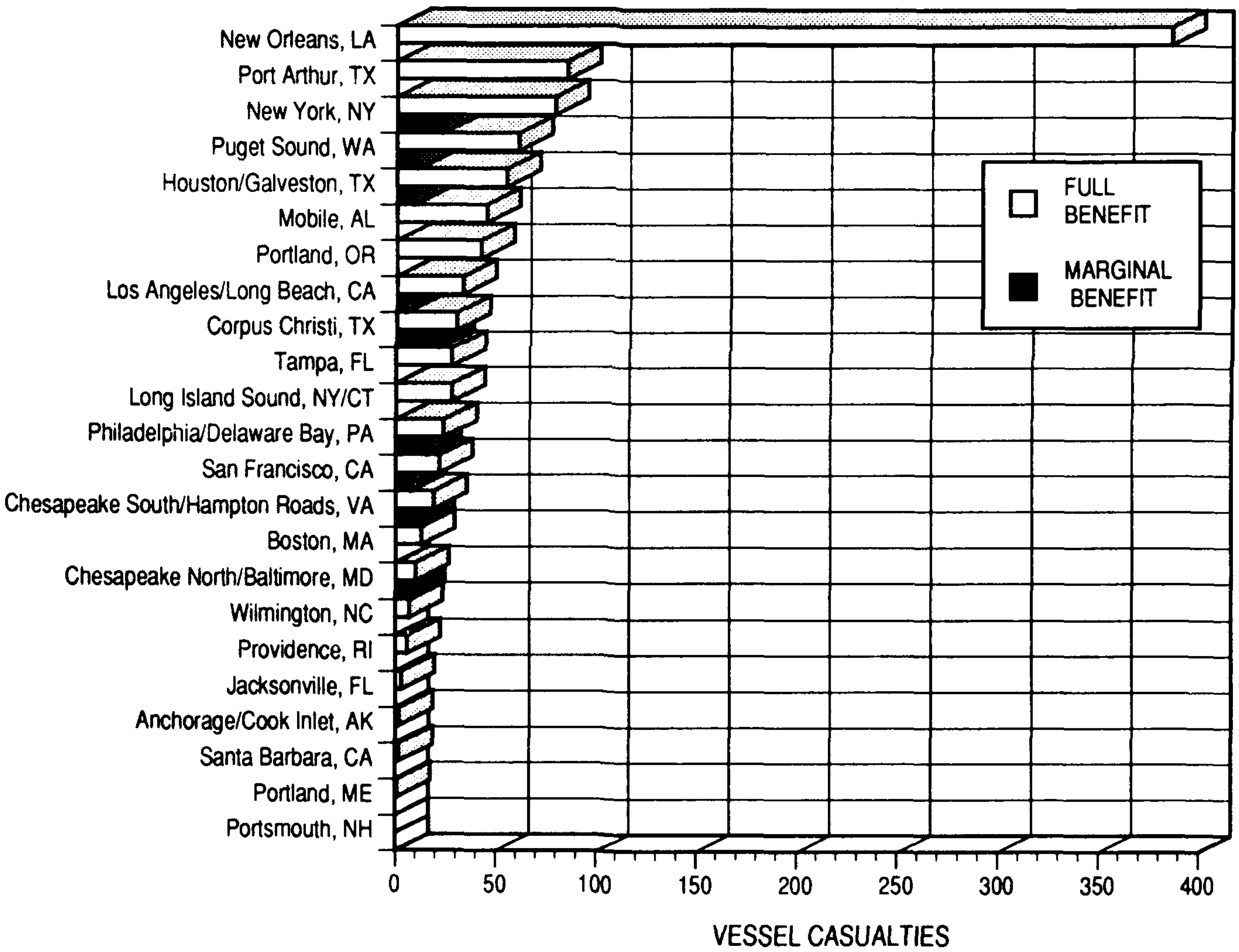


Figure 2: Avoided Vessel Casualties

Avoided Human Injuries and Deaths

If all 23 Candidate VTS Designs are implemented, a total of 138 injuries and 31 human fatalities can be avoided during the 15-year period.

Figure 3 displays the 23 study zones in descending order of avoided human injuries and deaths. New Orleans leads with 50 avoided deaths and injuries, followed by Puget Sound with 33 and New York with 14 avoided deaths and injuries.

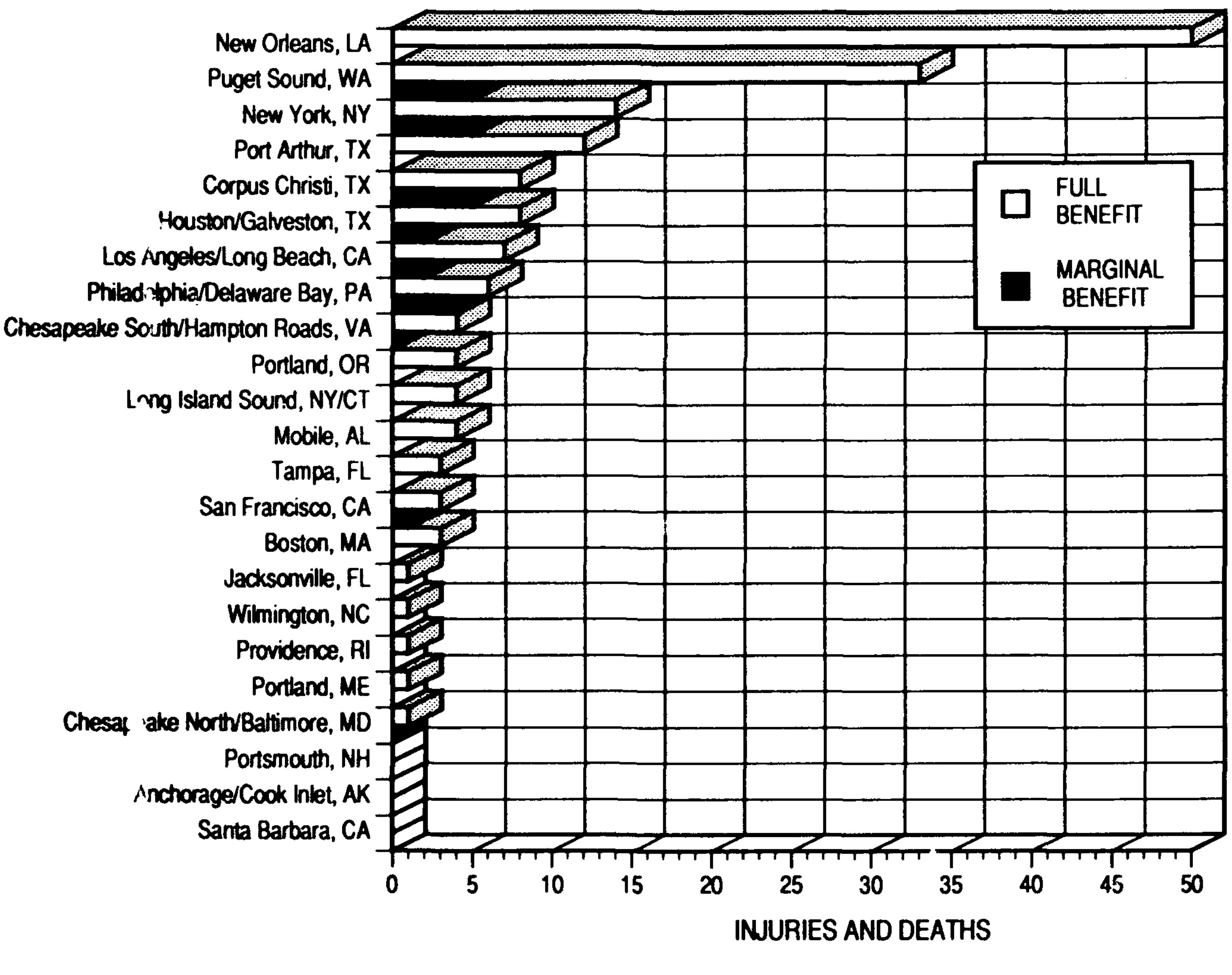


Figure 3: Avoided Human Injuries and Deaths

Avoided Hazardous Commodity Spills

If all 23 study zones implement the Candidate VTS Designs, a total of 100 hazardous commodity spills of all sizes can be avoided during the 15-year period. This includes bulk cargo spills from tankers and tank barges and vessel fuel (bunker) spills from all vessel types involved in vessel casualties resulting in vessel damage. In each of the top four zones, over 80% of the spills are 10,000-750,000 gallons each.

Figure 4 displays the 23 study zones in descending order of avoided hazardous commodity spills. New Orleans overwhelmingly leads with 40 avoided hazardous commodity spills. New York, Houston/Galveston and Puget Sound each have 8 avoided spills.

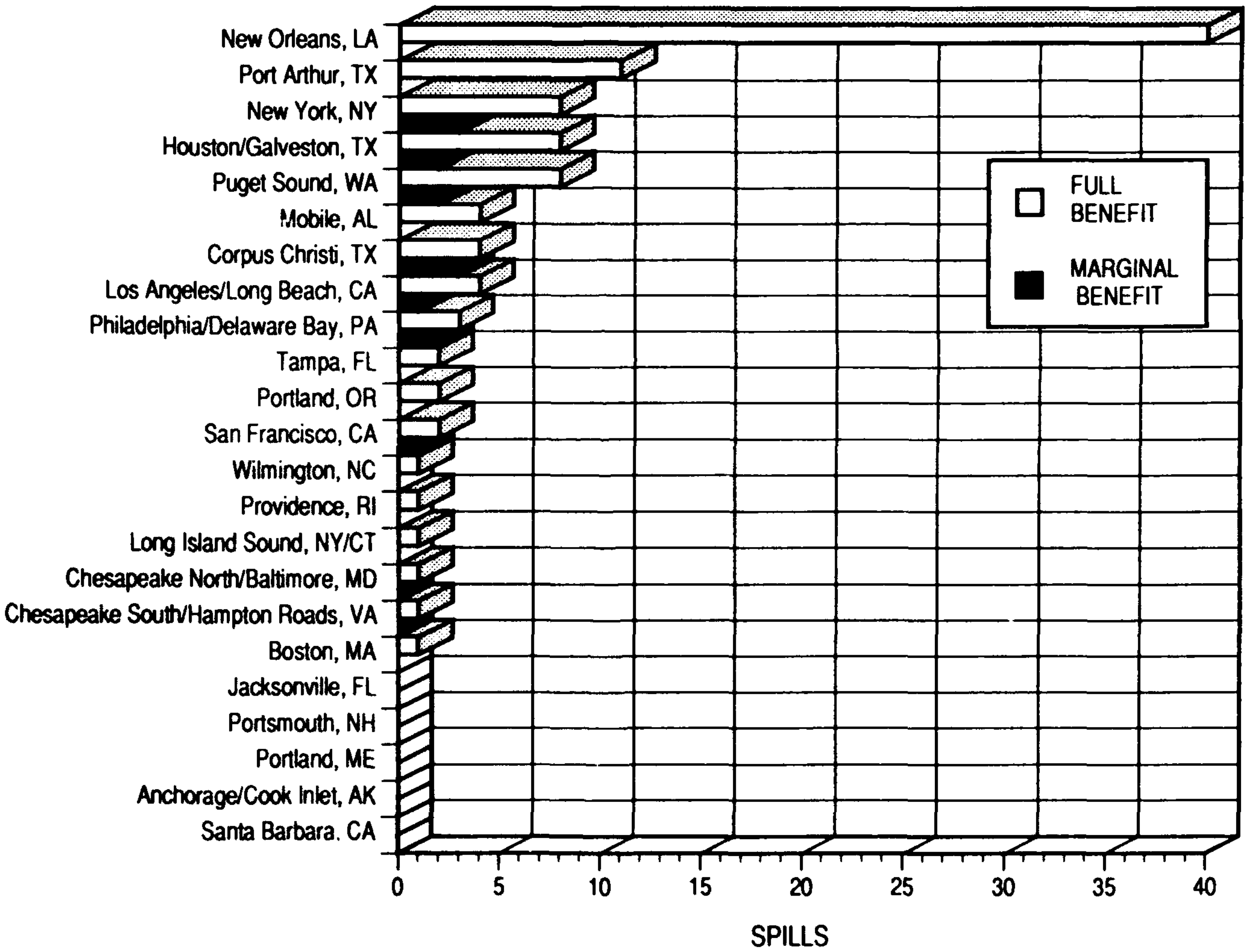


Figure 4: Avoided Hazardous Commodity Spills

Avoided Marine Mammal and Bird Losses from Hazardous Commodity Spills

Hazardous Commodity Spills result in environmental and commercial losses. If all 23 study zones implement the Candidate VTS Designs, a loss of 3.9 million individual marine mammals and birds from hazardous commodity spills can be avoided during the 15-year period.

Figure 5 displays the 23 stud᾽ zones in descending order of avoided marine mammal and bird loss to hazardous commodity spills. New Orleans leads with 1.6 million. Los Angeles/Long Beach has 550 thousand, Port Arthur has 522 thousand, and New York has 209 thousand individual marine mammal and bird losses from hazardous commodity spills.

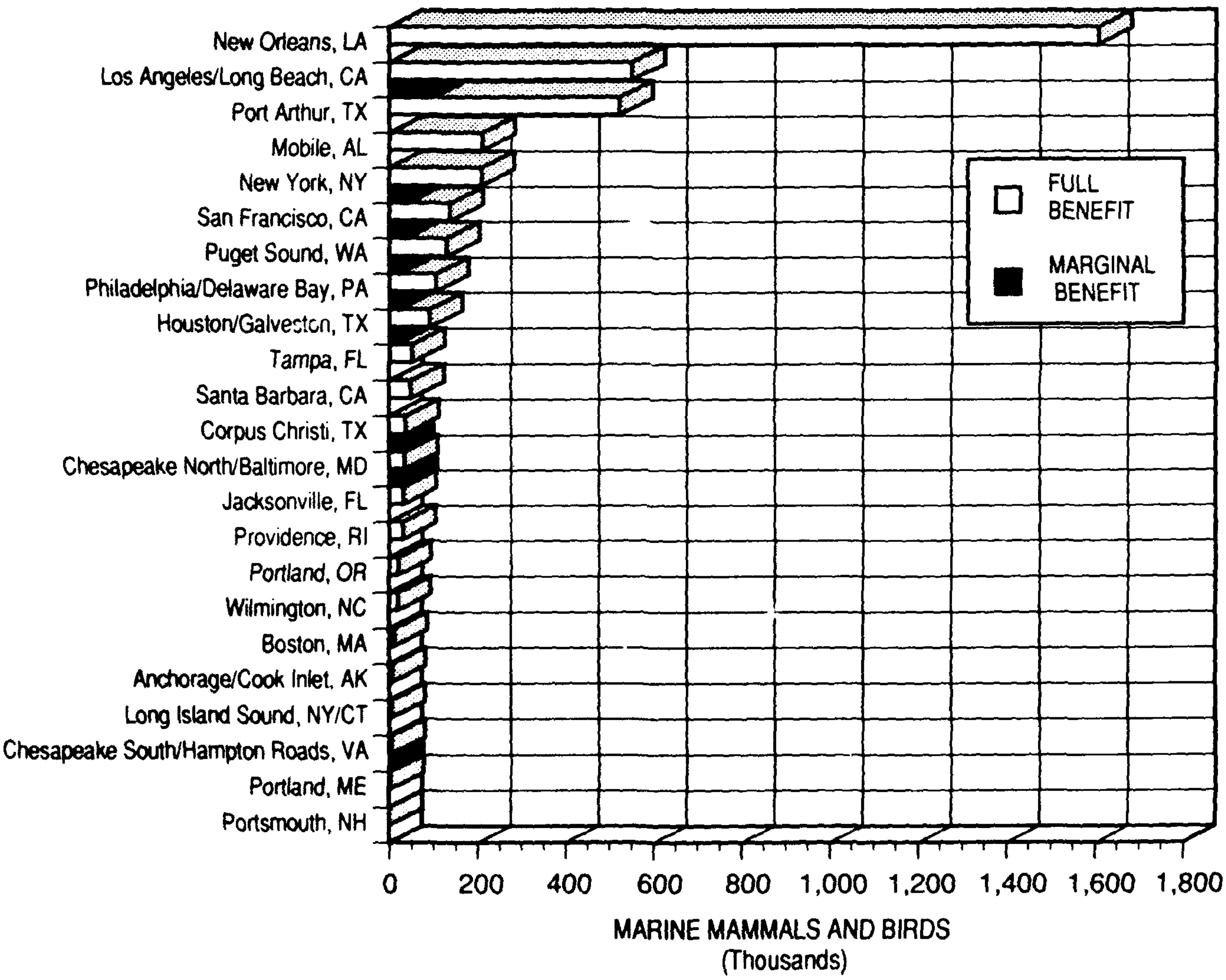


Figure 5: Avoided Marine Mammal and Bird Losses from Hazardous Commodity Spills

Avoided Commercial Fish Species Losses from Hazardous Commodity Spills

If all 23 study zones implement the Candidate VTS Design, a total of 396 million pounds of commercial fish species losses can be avoided during the 15-year period.

Figure 6 displays the 23 study zones in descending order of avoided commercial fish species losses from hazardous commodity spills. Houston/Galveston leads with 176 million pounds; Port Arthur and New Orleans follow with 67 million pounds each of commercial fish species losses from hazardous commodity spills.

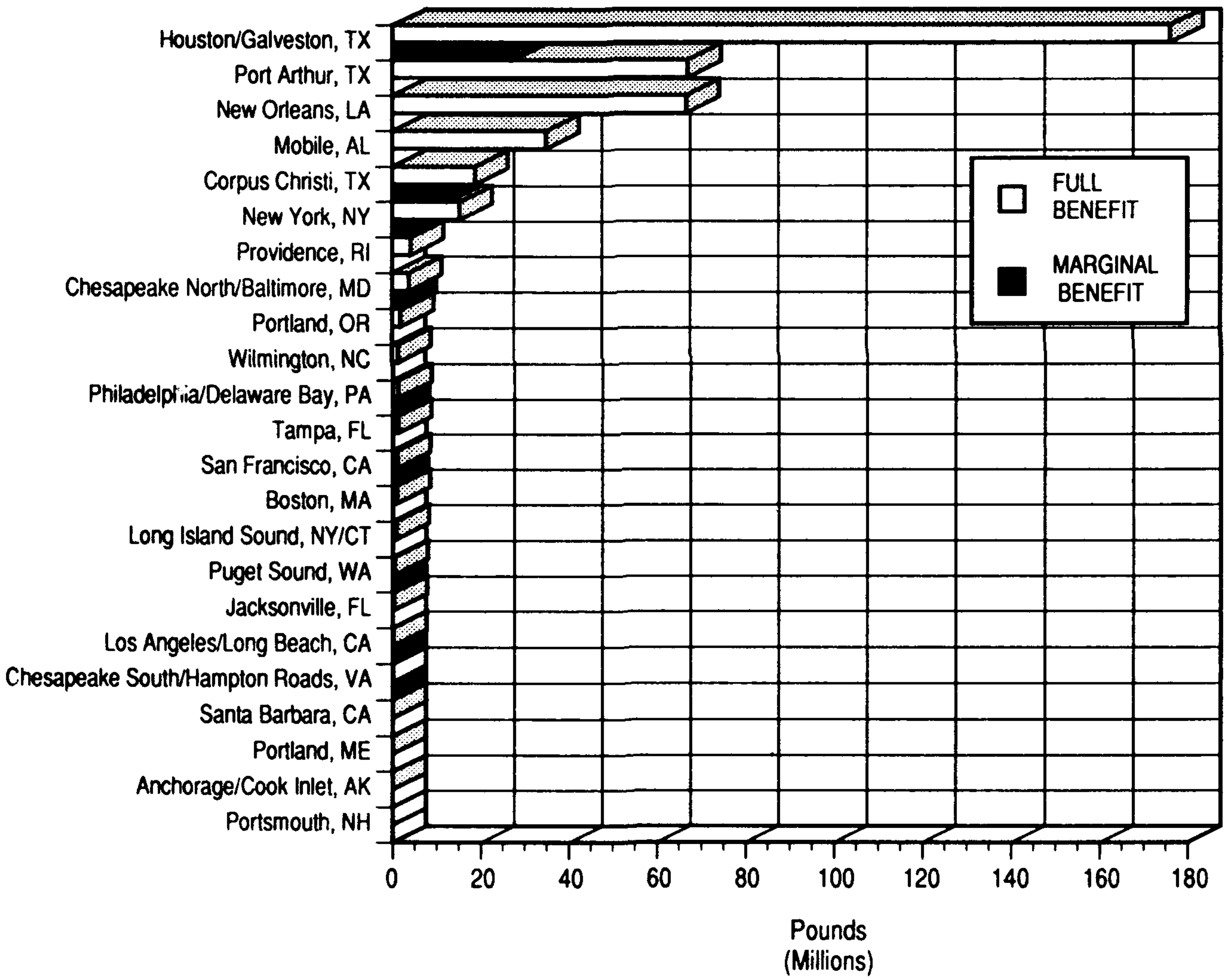


Figure 6: Avoided Commercial Fish Species Losses from Hazardous Commodity Spills

Avoided Dollar Losses of All Consequences - (Undiscounted 15 Year Total)

When all avoided vessel casualty consequences attributed to the 23 Candidate VTS Designs are converted to constant dollar values, the 15-year avoided losses total $1.9 billion (undiscounted).

Figure 7 displays the 23 study zones in descending order of total avoided dollar losses attributed to the Candidate VTS Designs. New Orleans, Port Arthur, Houston/Galveston, are responsible for 60% of this total; Mobile, Los Angeles/Long Beach, New York, and Corpus Christi, for an additional 23%. The first seven study zones are responsible for 83% of the total potential avoided dollar losses (undiscounted), attributed to the 23 Candidate VTS Designs. Figure 7 also displays the dollar values of the avoided losses attributed to the 9 Existing VTS Systems to highlight the incremental increases offered by the candidate VTS in those study zones.

Losses associated with hazardous commodity spills are responsible for 74%-94% of the total avoidable dollar losses in each zone. In each of these zones, cleanup costs are a large portion of the spill costs. However, in Los Angeles/Long Beach, property losses associated with spills reaching shore dominate. In Houston/Galveston and Mobile, the commercial fish species losses and cleanup costs dominate.

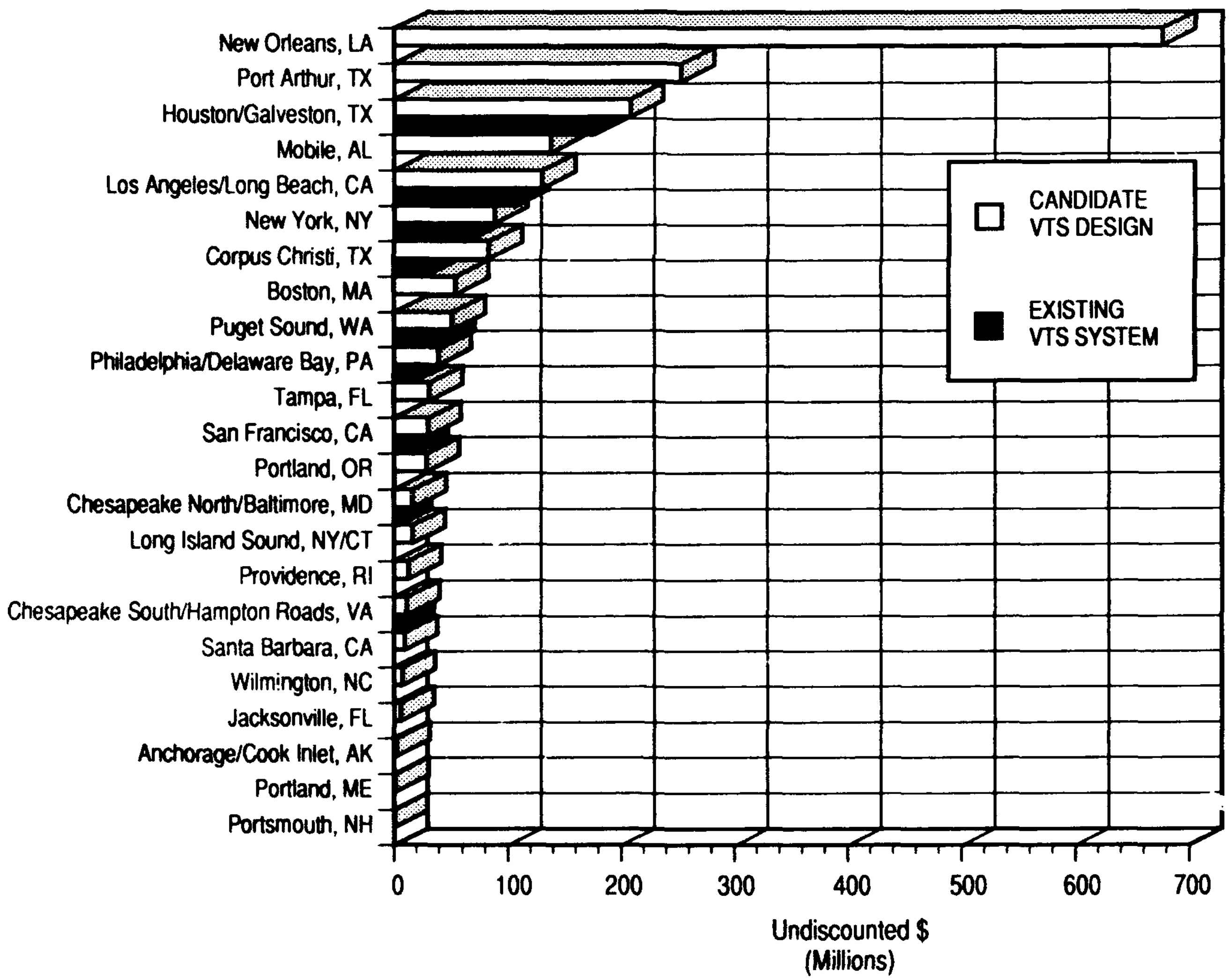


Figure 7:
Avoided Dollar Losses of All Consequences - (Undiscounted 15 Year Total)

Projected VTS Net Benefit

The 1993 discounted value of the 15-year life cycle Net Benefit (i.e., discounted annual stream of benefits minus the discounted annual stream of VTS investment and O&M costs) transforms all future benefits and costs to a single objective measure suitable for ranking the 23 study zones in terms of the aggregate national interest.

Table 1 lists the 23 study zones in the order of the study zone code number and displays the 1993 value of the total life cycle total benefits, total costs, and net benefits for the Candidate VTS Designs in each study zone. The benefits and costs are discounted to the beginning of FY 93, the time of the initial commitment of the VTS investment. The annual streams of VTS benefits and O&M costs begin in FY 96 and continue through FY 2010.

Table 1.
Study Zone 1993 Value of Life Cycle Benefit & Cost

ZONE	NAME	TOTAL BENEFIT ($1,000's)	TOTAL COST ($1,000's)	NET BENEFIT ($1,000's)
1	Boston, MA	23,149	7,999	15,150
2	Puget Sound, WA	21,717	25,724	(4,007)
3	Los Angeles/Long Beach, CA	55,848	13,021	42,827
4	Santa Barbara, CA	3,888	8,667	(4,779)
5	Port Arthur, TX	108,270	15,856	92,414
6	New Orleans, LA	290,771	37,036	253,735
7	Houston/Galveston, TX	89,661	28,646	61,014
8	Chesapeake South/Hampton Roads, VA	4,531	22,918	(18,387)
9	Chesapeake North/Baltimore, MD	6,924	8,593	(1,669)
10	Corpus Christi, TX	35,424	9,311	26,113
11	New York, NY	35,480	26,445	9,036
12	Long Island Sound, NY/CT	6,837	9,084	(2,248)
13	Philadelphia/Delaware Bay, PA	16,221	14,032	2,189
14	San Francisco, CA	12,694	22,624	(9,930)
15	Portland, OR	11,850	9,647	2,203
16	Anchorage/Cook Inlet, AK	935	14,473	(13,538)
17	Portland, ME	410	7,687	(7,277)
18	Portsmouth, NH	23	6,107	(6,084)
19	Providence, RI	5,281	7,265	(1,984)
20	Wilmington, NC	2,939	7,586	(4,647)
21	Jacksonville, FL	2,473	6,421	(3,948)
22	Tampa, FL	13,185	8,008	5,176
23	Mobile, AL	57,747	9,606	48,141
Totals		806,225	326,756	479,449

Projected VTS Net Benefit *(cont'd.)*

Figure 8 displays the 23 study zones in descending order of the Net Benefit. In the nine study zones with operating Existing VTS Systems, the upper bar indicates the full Net Benefit of the Candidate VTS Design, and the lower bar the marginal Net Benefit.

Considering the Full Net Benefit, the first 11 study zones are positive and the next 12 are negative. Viewing from the perspective of the Marginal Net Benefit, the rank order changes somewhat. The most significant changes are Los Angeles/Long Beach, which shifts from a substantial positive net benefit to a slightly negative benefit and Puget Sound which changes from a negative net benefit to a substantially positive net benefit. The positive marginal net benefit in Puget Sound reflects the fact that the reduction in annual O&M cost exceeds the incremental investment for the Candidate VTS Design in that study zone. Philadelphia/Delaware Bay, with the lowest positive full net benefit, changes to a negative when the marginal net benefit is considered.

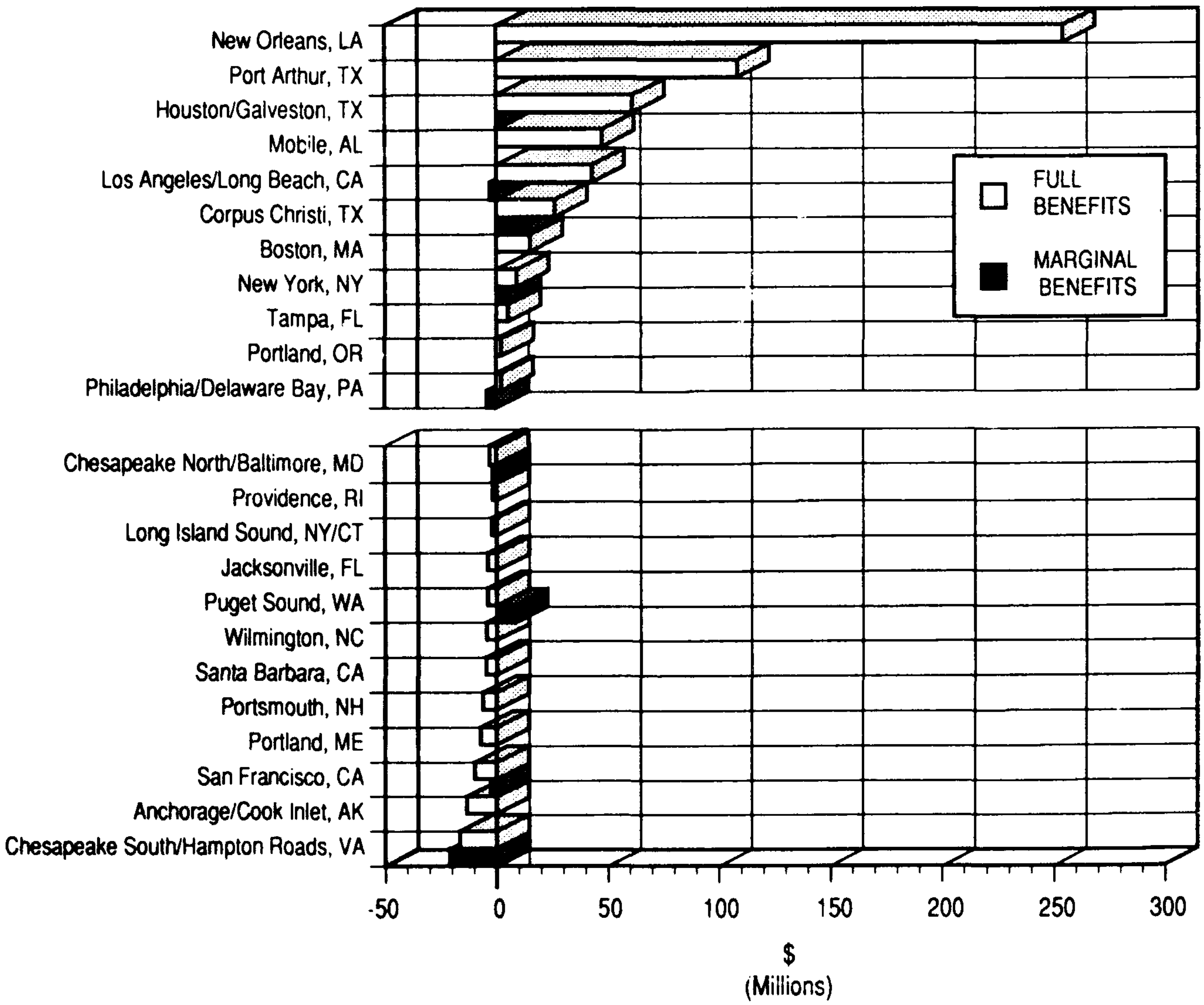


Figure 8: 1993 Value of Projected VTS Life Cycle Net Benefits

Sensitivity

Uncertainty of Study Variable Estimates

The study evaluates the sensitivity of the relative net benefits among the 23 study zones to any uncertainty relating to selected major input variables. The analysis first takes a global perspective of the analytical process and tests selected inputs for all 23 study zones concurrently.

The sensitivity of the net benefits to any uncertainty relative to selected major variables is examined first by varying the VTS costs and the VTS benefits by fixed percentages.

The effect of a 50% increase in the estimated VTS costs in each zone results in minor changes in the rank order of the 23 study zones. The most significant change is that New York, Portland, OR, and Philadelphia/Delaware Bay shift from a positive to a negative net benefit.

The effect of a 50% reduction in the estimated total benefit in each zone results in some changes in the rank order. The most significant change is that New York, Tampa, Portland, OR, and Philadelphia/Delaware Bay shift from a positive to a negative net benefit.

The effect of a 50% increase in the estimated total benefit in each zone also results in some changes in the rank order. The most significant change is that Puget Sound, Chesapeake North/Baltimore, Long Island Sound and Providence each shift from a negative to a positive net benefit.

Sensitivity *(cont'd.)*

Zone Specific Dominant Avoided Losses

In addition to the sensitivity of the relative net benefits across all 23 study zones to the basic analytical methods and input data, there may be some concern over estimates of selected types of VTS avoided losses in one or more of the study zones. To address this concern, the focus shifts to the individual study zone's net benefits and the specific loss type(s) that dominate the VTS benefits in each of these zones.

Considering the Full (rather than the Marginal) Net Benefit, the sensitivity of the net benefits may be assessed in terms of the study zone's respective dominant loss type and the effect that any uncertainty about that loss might have on the net benefit, and the rank order.

Table 2 lists the study zones in rank order by Net Benefit and highlights the dominant categories of avoided losses in each zone.

Table 2. Rank Order by Net Benefit

Rank	Zone	Net Benefit (millions)	Largest Avoided Loss
1.	New Orleans	$254	Hazardous commodity spills cleanup (50% of total)
2.	Port Arthur	$92	Hazardous commodity spills cleanup (48% of total)
3.	Houston/Galveston	$61	Commercial fish species (42% of total) and cleanup (30% of total)
4.	Mobile	$48	Hazardous commodity spills cleanup (38% of total) and commercial fish species (34% of total)
5.	Los Angeles/Long Beach	$43	Property damage from hazardous commodity spills (55% of total)
6.	Corpus Christi	$26	Hazardous commodity spills cleanup (40% of total) and commercial fish species (29% of total)
7.	Boston	$15	LNG explosion damage (63% of total). LNG loss is the dollar value of all deaths, injuries, and material losses associated with LNG explosions during the 15-year period (i.e. a total expected value of 0.016 or an average annual expected value of 0.0011 which translates to approximately one probable LNG explosion in 1,000 years). The probability of an LNG vessel casualty (which is assumed to precede an explosion) is estimated at 10% of other large tankers in the zone.
8.	New York	$9	Hazardous commodity spills cleanup (55% of total)
9.	Tampa	$5	Hazardous commodity spills cleanup (52% of total)
10.	Portland, OR	$2	Hazardous commodity spills cleanup (47% of total), property damage (15% of total) and vessel damage (15% of total)
11.	Philadelphia/Delaware Bay	$2	Hazardous commodity spills cleanup (60% of total)

Table 2. Rank Order by Net Benefit *(cont'd)*

Rank	Zone	Net Benefit (millions)	Largest Avoided Loss
12.	Chesapeake/North Baltimore	($2)	Hazardous commodity spills cleanup (36% of total) and commercial fish species (37% of total)
13.	Providence,RI	($2)	Hazardous commodity spills cleanup (48% of total)
14.	Long Island Sound	($2)	Hazardous commodity spills cleanup (50% of total)
15.	Jacksonville	($4)	Hazardous commodity spills cleanup (47% of total)
16.	Puget Sound	($4)	Hazardous commodity spills cleanup (37% of total) and vessel damage losses (18% of total)
17.	Wilmington, NC	($5)	Hazardous commodity spills cleanup (45% of total) and vessel damage (18% of total)
18.	Santa Barbara	($5)	Property damage (54% of total)
19.	Portsmouth, NH	($6)	Vessel damage (40% of total) and cleanup (33% of total)
20.	Portland, ME	($7)	Hazardous commodity spills cleanup (48% of total)
21.	San Francisco	($10)	Hazardous commodity spills cleanup (45% of total)
22.	Anchorage/Cook Inlet	($14)	Hazardous commodity spills cleanup (50% of total)
23.	Chesapeake South/ Hampton Roads	($18)	Hazardous commodity spills cleanup (45% of total)

In each of these study zones, the effect of the level of uncertainty with respect to the dominant loss type(s) on the net benefit can be estimated by application of a factor to each dominant loss type considered suspect. This level of sensitivity analysis may be conducted by the reader in conjunction with a review of the detailed study zone specific statistics presented in the appendix tables, Volume II, of the study final report.

Findings

The study indicates that the 23 study zones can be divided into three groups in terms of their relative life cycle net benefits. Analysis of the sensitivity of the relative values of net benefits to underestimates or overestimates of the VTS benefits or the VTS costs suggests the following groupings. The first seven zones have a positive net benefit over the range of uncertainty tested.

Positive Net Benefit:

- New Orleans
- Port Arthur
- Houston/Galveston
- Mobile
- Los Angeles/Long Beach
- Corpus Christi
- Boston

The net benefits of the following eight zones may be considered sensitive because their relative values are comparatively small, and may be positive or negative over the range of uncertainty tested.

Sensitive Net Benefit:

- New York
- Tampa
- Portland, OR
- Philadelphia/Delaware Bay
- Chesapeake North/Baltimore
- Providence
- Long Island Sound
- Puget Sound

The following eight study zones retain their negative net benefit status over the range of uncertainty tested.

Negative Net Benefit:

- Jacksonville
- Wilmington
- Santa Barbara
- Portsmouth
- Portland, ME
- San Francisco
- Anchorage/Cook Inlet
- Chesapeake South/Hampton Roads